AN
ACCOUNT
OF SOME
GERMAN VOLCANOS, &c.

Speedily will be publiſhed,

IN ONE VOLUME OCTAVO,

MINERALOGICAL AND BOTANICAL

TRAVELS THROUGH ITALY;

Written in the German Language by

Mr. FERBER.

Tranſlated into Engliſh by R. E. RASPE.

Printed for LOCKYER DAVIS.

BRITISH MUSEUM

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AN ACCOUNT
OF SOME
GERMAN VOLCANOS,
AND THEIR PRODUCTIONS.
WITH A NEW HYPOTHESIS OF THE PRISMATICAL BASALTES; ESTABLISHED UPON FACTS.

BEING

AN ESSAY OF PHYSICAL GEOGRAPHY
FOR PHILOSOPHERS AND MINERS.

PUBLISHED AS SUPPLEMENTARY TO
SIR WILLIAM HAMILTON'S OBSERVATIONS
ON THE ITALIAN VOLCANOS.

By R. E. RASPE.

K

In nova fert animus mutatas dicere formas.

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MDCCLXXVI.

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From
the Author.

Jos: Banks

ADVERTISEMENT.

MANY Philoſophers having of late made uſe of volcanos and earthquakes as undoubted active principles to explain the inequalities of the earth, it is matter of juſt ſurprize why the various nature of volcanos and their productions ſhould be ſo long neglected. The Author therefore conſidered the following facts as natural Supplements to Sir William Hamilton's valuable accounts of the Veſuvian eruptions, and hopes they will be received as improvements of uſeful Science.

There is the leſs occaſion to enlarge upon the advantages of Geographical, Phyſical, Mineralogical, and Chemical Obſervations, as it is obvious that, by rectifying the different romantic hypotheſes of the earth, they afford Philoſophers an opportunity not only to improve the ſyſtem and claſſification of Foſſils, but what is above any ſcientifical nomenclature, to lay down ſure principles for the too-much neglected and expenſive art of Miners. Many curious obſervations to that purpoſe have been made of late in Italy, Hungary, Dalmatia, and Germany, by Mr. Ferber, Baron Born, and Alb. Fortis, in their Mineralogical and Botanical Travels: all which the Author has an intention of publiſhing in the Engliſh language.

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PART I.

DESCRIPTION OF THE VALLEY OF CASSELL.

§ 1. *General Form.*

THE large valley, wherein the city of *Caſſell* is ſituated, is on every ſide incloſed by a vaſt circle of high mountains, and interſected by different lower ſloping hillocks.

§ 2. *Sand-ſtone Mountains, which incloſe it on one Side.*

The *higher mountains* extend on the South Eaſt part of the river Fulde, from Munden in the Electorate of Hanover, Landwernhagen and Spickerſhauſen, to Sichelſtein, Wendhauſen and Kauffungen; and thence behind Oxhauſen and Crumbach to Bergſhauſen, at which place they are called the Soere-Foreſt, and are cut through by the Fulde.

This whole ridge or chain of mountains conſiſts, as far as I know, of Sandſtone-Strata, which are generally horizontal. Never containing any marine bodies, I ſhould be inclined to conſider them as *original* or *primogenial mountains*, and to rank them with the pretended primogenial hornſlate-granites and metallic-mountains, which in no reſpect have any better claim to ſuch a denomination, and ſhould rather be called the moſt ancient mountains, as being generally covered by more modern ſtrata.

Branches of theſe ſand rocks ſtretch near Wolfanger and Berghauſen over the Fulde, and run, near the former place, Simmerſhauſen and Knickhagen, to the Reinarts-Foreſt; but on this ſide of Berghauſen and Freienhagen they are blended with and loſt under ſeveral lower hills and under the higher Habichwald, as appears by ſome memorable circumſtances deſcribed in the ſequel.

§ 3. Habichwald, *which incloſes it on the other Side.*

The *Habichwald*, whoſe ſteep and ſhaggy ſummits compoſe the ſecond or the North-Weſt part of the before-mentioned wide circle of higher mountains, is entirely different from the nature of theſe ſandſtones. It is remarkably the higheſt ridge of mountains thereabout, and, including the Dörnberg, with ſeveral mountains of the like nature, it forms a large ſquare of the country, its outline, of above four German or twenty Engliſh miles, running from Weiſſenſtein to Harleſhauſen, Heckerſhauſen, Weimar, Zierenberg, Dornberg, Ehlen, Elgerſhauſen, Alten-Ritta, Alten-Bauna, Nordſhauſen, and Wahlerſhauſen. My readers, who have never happened to be in this country, ſo much deſerving to be ſeen, and ſo much ſignalized by Britiſh valour, are referred to an excellent Plan, drawn by Captain Dumont de Venemont, and publiſhed with an account of the glorious expeditions of the allied armies after the battle of Wilhelmſthal, which was fought in *June* 1762 *. This plan is a model of an excellent topographical map, and will give a diſtinct idea of the different and relative elevation of the mountains, of their direction, and of the extent of the beautiful valley of Caſſell now under conſideration.

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* Plan de la premiere partie des Operations faites par l'armée alliée contre l'armée Françoiſe en 1762; to be had at Heydinger's in the Strand.

§ 4. *Lower*

§ 4. *Lower hills of this valley deſcribed in general.*

The *lower hills* of the large valley, included by the above-mentioned higher ones, are, on the N. W. ſide of the Fulde, either of a calcareous nature, or compoſed of the accumulated decays and rubbiſh [*geſhube*] waſhed down from, and belonging to the ſurrounding Habichwald.

§ 5. *The calcareous ones are an ancient ſtratified bottom of the Sea.*

The *calcareous hills*, eſpecially the Wineberg and Krazenberg, on which the city of Caſſell is ſituated, together with the Monkberg, which runs from the city up to Upper-Vilmar, conſiſt of parallel ſtrata; dip in different inclinations to the South; run in a N. W. direction, and ſhew in a certain depth a hard marble-like blueiſh-grey limeſtone, which is broken into many vertical fiſſures, and is filled with ſome ſcarce petrifications,

fications, or rather nuclei of, for the moſt part, unknown marine bodies, ſuch as cornua ammonis, entrochi, and the like ſpecies pelagiæ of plants and animals inhabiting the deepeſt ſeas.

Hence it is evident, that theſe calcareous ſtrata have been anciently the bottom of a ſea; but when, or for how many centuries, cannot poſſibly be gueſſed. We ſee however the moſt evident proofs of its having depoſited rubbiſh and ſhells. Theſe beds have probably been ſhaken and ſplit by earthquakes, which have raiſed and brought them to their preſent inclinations to the horizon.

§ 6. *Uncertain on what ſort of ground accumulated.*

I have not hitherto diſcovered to full ſatisfaction on what ſort of ground theſe ſtrata were accumulated, when this part of the continent was covered with ſea; but probably it was in ſome places a ſandſtone-rock, as one may gueſs by its before-deſcribed neighbourhood, and by ſeveral circumſtances, which ſhall be taken notice of in the ſequel. In ſeveral other places it might be argillaceous ſlate, which Mr. Ferber * from the Alps to the moſt Southern parts of Italy has conſtantly found below the calcareous hills of that country. A ſtratum of blue clay, diſcovered and laid open by the brook of Welheiden, in the valley below the Wineberg near Caſſell, countenances this opinion.

§ 7. *Covered by different modern Strata.*

Our calcaceous ſtrata are covered by,

1. A clayiſh mould (*humus hortenſis argillacea*).

2. Yellow ferrugineous loam or brick-clay.

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* See his Letters on the Natural Hiſtory of Italy, printed in German at Prague 1773; which will ſoon appear in the Engliſh language.

3. Yellow,

3. Yellow, greeniſh, and reddiſh marle, more or leſs petrified, which in this country goes under the name of Monkberg, perhaps becauſe the before-mentioned hill of that name has no other exterior mould but this ſort of marle. Immediately after theſe beds, follow the limeſtone ſtrata.

§ 8. *Large Bones found buried in them at* Caſſell.

Foundations of buildings cannot be ſafely laid in the upper part of Caſſell but in or upon this marle-ſtratum, which very often puts the builders to great expence; and has occaſioned, when that part of the city was firſt planned out for the French Refugees, a diſcovery deſerving notice. It is ſaid, and there is no reaſon to doubt it, that they found then in one of the ſuperior clay-ſtrata ſeveral bones and teeth, belonging to an elephant, or to a quadruped of a like ſize, which are kept in the Landgrave's public collection of foſſils. The tuſks then dug out, according to the dimenſions of the ſeveral fragments, are judged to be above three feet in length. The grinders are of a proportionable bigneſs.

§ 9. *General conſideration of theſe bones, and concluſion that they belonged to an unknown ſpecies of quadrupeds.*

Bones and teeth of the ſame kind have been found in the moſt Northern countries, and even in North America, under the ſame circumſtances; that is, laying in a ſtate of calcination in the uppermoſt earth-clay and ſwamp-ſtrata, or in ſubterraneous caverns; and being never mixed with marine productions, or incloſed in ſound ſtone-beds, there is good reaſon to believe that ſuch bulky quadrupeds have been in former times, after the ſea had retired, indigenous inhabitants of the countries where their remains are dug out. I will not repeat the difficulties, for the moſt part imaginary ones, which have hitherto attended the explications of this ſingular phænomenon; nor will I tire my readers by relating the unneceſſary pains taken by the ingenious, to free the queſtion from theſe difficulties. I would rather refer them to a Diſſertation of the celebrated Anatomiſt Dr. Hunter *, and to another of my own †, concerning a great quantity of ſuch ſkeletons, which ſome years ago were diſcovered near the Ohio in North America. Dr. Hunter demonſtrates, that the grinders and ſeveral other of theſe bones do not belong to elephants, but to an unknown ſpecies of carnivorous animals; and after ſome ſtrong inductions againſt the changes in the inclination of the Ecliptic, which without any neceſſity, or good evidence, have been ſuppoſed to explain this phænomenon, I have hazarded the conjecture, that this ſpecies of carnivorous animals, and perhaps a more Northern kind of elephants, has been extirpated, perhaps by the ſame means as were employed with the

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* Philoſ. Tranſ. vol. LVIII. † Ibid. vol. LIX.

like ſucceſs againſt the lions in the Southern parts of Europe, againſt the wolves and wild boars in England, and againſt the bears, urus', and elks in Germany, which Cæſar, though he never penetrated further than the Rhine, mentions as inhabitants of Germany *. But I return to our calcareous hills.

§ 10. *The calcareous Strata covered with old decays of the* Habichwald, *rolled and waſhed down to* Welheiden.

Beyond Welheiden, on the left of the new-planted green road which leads to Wiſſenſtein, theſe ſtrata are loſt under a gentle ſloping ground, which aſcends to the Habichwald and the Druſelthal, and chiefly conſiſts of the decays and rubbiſh of the high-towering ſteeper Habichwald, that thence have been waſhed and rolled down upon the limeſtone by the ever-mining waters of a rapid rivulet, called the Druſel.

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* Cæſar de Bello Gallico, lib. vi.

[See Pl. I.] This rivulet ſprings on the very ſummit of the Habichwald, and, though inconſiderable in dry weather, acquires very often, by heavy rains or melting ſnows, impetuous force. Under whatever ſuppoſition we conſider this ground, whether it be accumulated on the limeſtone ſtrata when ſtill covered with ſea, or after the ſea had left them bare and dry, its height and large extent obliges us to believe it a work of many ages, and that a long ſeries of centuries was requiſite for ſo ſmall a rivulet to force its way to the depth of a valley like the Druſelthal, through the high rocks of the Habichwald, thence to tear and to carry of ſuch an immenſe quantity of hard ſtones, to roll theſe decays on the limeſtone ground at a diſtance of three Engliſh miles, near to the very gates of Caſſell, and finally, to grind and to blunt theſe ſtones, which moſtly are as hard as flint, into the pebble-like form, in which they appear every where, and eſpecially on the borders of the rivulet, which viſibly, even at preſent,

ſent, never ceaſes in its unwearied courſe to blunt, by rolling, whatever lyes in its way.

§ 11. *Covered with a bed of aſhes at* Wiſſenſtein.

Between Wahlerſhauſen and Wiſſenſtein the calcareous ſtrata are loſt under, and covered with a hill, on which the caſtle and the *platte forme* of Wiſſenſtein are ſituated. [See Pl. I.] This hill is a maſs of a ſpungy, fine and grey blueiſh mould like aſhes, waſhed down from the higher and immediately connected Habichwald. It cannot be ranked among the clays, marles, and ſands, ſince it has not their requiſite toughneſs, coheſion, efferveſcence, and palpability.

§ 12. *Covered with decays of the* Habichwald *in many places.*

Near Kirchditmold the calcareous ſtrata aſcend gently up to the Habichwald, and diſappear under its ruins.

On the ſide of this high foreſt they baſſet out behind Upper-Vilmar, near Willemſthal, Calden, Franckenhauſen, Burg-Uffelen, and Grabenſtein.

§ 13. *Run under different ſuperincumbent mountains.*

Behind the Habichwald and Harleſhauſen they appear again from under its decays, aſcend to the iſolate Dornberg, whoſe foundation is entirely calcareous, and run by the way of Zierenberg and Weſt-Uffelen, in the country of Waldeck, beyond the Diemel, in the Biſhoprick of Paderborn, and thence into the Foreſt of Teutoberg, in the county of Lippe.

§ 14. *Concluſion of their high Antiquity; inferior to that of the ground on which they are accumulated, but anterior to that of their ſuperincumbent mountains.*

I have ſeveral times travelled over theſe parts, and after repeated examination found, that their limeſtone ſtrata, though now and then interrupted and covered by large valleys, being throughout of the ſame colour and ſubſtance, and containing the ſame ſorts of petrifications or nuclei of conchæ, and ſpecies pelagiæ, are of the ſame kind. This gives me a right to conclude;

1. That all theſe parts of the continent have been covered with a ſea for as many ages as might be requiſite to produce, at its deepeſt bottom, ſo great a variety of calcareous ſtrata.

2. That theſe ſtrata are of a newer date than the above-mentioned ſandſtone, or argillaceous ſlate ſtrata, which lye deeper, and are [See Pl. I.] of the higheſt antiquity.

3. That they are anterior to the decays of the Habichwald [See Pl. I.]; and,

4. Even of a more ancient origin than the Habichwald, the Dornberg, and ſeveral other ſuperincumbent hills of that kind. [See Pl. I.]

I am not inclined to loſe myſelf in a nearer examination of their antiquity, which my readers are deſired to fix as they pleaſe, according to the wants or to the advantages of that ſyſtem of Chronology, which they have a mind to, or are convinced of.

§ 15. *Level of the Sea, which covered or produced them.*

There is more hope of ſucceſs and ſatisfaction in determining the level of the ſea, which once covered or produced theſe calcareous ſtrata, or this ancient ſea bottom. It is traced on the ſides of the higher ſurrounding hills of the large valley of Caſſell, by a ſtratum of ſea mud, which in ſeveral places I have examined myſelf, and according to repeated menſurations found to lie in all theſe places on the ſame elevation. [Plate I.]

This remarkable ſtratum is to be met with in the Sneckenberg within the garden at Wiſſenſtein [Plate I.]; and on both ſides along the deſcent of the Habichwald, near that place. I ſaw it likewiſe on the other ſide of the river Fulde, at a diſtance of ſeven or eight Engliſh miles, in the deſcent from Wendhauſen to Kauffungen; and it occurs again at a ſtill greater diſtance, that of at leaſt ten Engliſh miles from Caſſell, near Deuten, Beſſe, and Gudenſberg. In all theſe places it is at the ſame horizontal elevation as marked in the Section Plate I. and of the ſame nature. It conſiſts of a friable, and more or leſs indurated ferrugineous marle or mud, of an ochraceous yellow-browniſh colour; and it contains an innumerable quantity of calcined littoral-ſhells, ſuch as Chamas craſſas majores læves æquales polyginglymas; Conchas cordatas læves majores & minores; Pectines auritos minores; Turbines; Cochleas; Strombos minores; Entalia; Tubulos vermiculares; and finally, ſome ſmall Coral-fungites — that are known ſpecies and common on many ſhores of the Northern ſeas and ſtrong evidences that an ancient ſea covered that part of the Continent at this level. It was perhaps the ſame ſea, which produced the above-mentioned calcareous ſtrata and ſpecies marinas pelagias; and having left ſo many evident littoral-traces on the ſides of the Habichwald, one might ſeem entitled by that circumſtance to ſuppoſe, that the Habichwald, and the like ſort of mountains, which are accumulated on a marine limeſtone ground, have been produced in the midſt of that ancient ſea, long before it retreated.

§ 16. *The higheſt hills, which incloſe the valley, have once appeared above it as ſo many Iſlands.*

The higheſt ſummits of the higher mountains, which incloſe the valley of Caſſell, muſt accordingly needs have been above the level of this ancient ſea as ſo many iſlands; but eſpecially the Habichwald, the Dornberg, and ſeveral other hills on the N. W. of the river Fulde, which, from their ſtructure, and the nature of their foſſils, I conclude to be a ſort of mountains entirely different from all the before-mentioned ſuppoſed original arenaceous and ſecondary calcareous ones.

PART II.

DESCRIPTION OF THE HABICHWALD, AND OTHER MOUNTAINS OF THE SAME NATURE.

§ 1. *They are ſuperincumbent on calcareous ground; and accordingly new mountains.*

I Come to a more minute deſcription of the Habichwald, and other mountains of the ſame nature. They are ſuperincumbent mountains (Aufgeſezte Berge) ſurrounded on all ſides by lower calcareous hills, on which they are accumulated. This, though obvious in many other places, is more clearly to be ſeen and to be evidenced by the Dornberg, which to the middle of its elevation is entirely calcareous, and leaves no room for any conjecture of ſuch hills being original or primogenial mountains.

They cannot be conſidered neither as accumulated by the action of the ſea (Flotz-Geburge), ſince they are deſtitute of the parallel-ſtrata of marine mountains: and though now and then there appear in them ſomething like parallel-ſtrata, there is never found incloſed in their ſubſtance any thing like adventitious organic marine productions.

Nor can they have been accumulated or depoſited by rivers and brooks, ſince there is no higher ground, whence they could have been ſuppoſed to flow; and ſince the ſlime or mud of rivers and brooks are no where found to produce rock ſo hard and vitreſcent as theirs.

It would be equally hazardous to attempt explaining their origin by pretended inundations, covering and overflowing their higheſt ſummits. I ſhall not inſiſt on the deficiency of water; and I will grant for a moment, that the fountains of the deep, and the windows of heaven, or an auxiliar comet's tail, and other ſuch miraculous unevidenced and improbable hypotheſes, could have once drowned the world. But would that give them their vitreous nature? Inundations can be ſuppoſed to produce, by the depoſitions of their ſediments, a variety of parallel ſtrata, which does not appear in the mountains we treat of; but they never can have compoſed wild vitreous rocks, in that ſituation, form, and quality, in which they appear in the ſolid and large maſſes, or huge pointed tops of black rocks, belonging to the higheſt elevation of the Habichwald, Dornberg, and others.

But perhaps they may have been accumulated on the limeſtone in theſe unweildy, uncouth, enormous maſſes, by ſucceſſive ſediments of hot wells, or incruſtating waters; or produced in the ſame manner as the ground near Radicoſani, a deſcription of which I have laid before the Royal Society at London*; or depoſited as the calcareous tophus, or oſteocolla-ſtratum, near Zierenberg in Heſſe, at the very foot of Dornberg, is daily increaſed; or raiſed in the ſame manner as the white ſaline marble and alabaſter hills ſeem to have been compoſed†. This conjecture may be ſupported by the calcareous ſtrata on which they are ſuperincumbent, and which poſſibly here, as commonly in the places beforementioned, might produce ſuch incruſtating wells and waters; but it is abſolutely inconſiſtent with the vitreous nature of the mountains and maſſes under conſideration, ſince all ſediments, precipitations, and incruſtations, of hot wells and waters, are of a calcareous or ſelenitic nature, effervescent by the action of the acids, and eaſily brought to calcination by common fire.

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* Phil. Tranſ. Vol. LXI. † Ibid. l. c.

§ 2. *Raiſed and accumulated by ſubterraneous fire.*

Theſe conſiderations and circumſtances do not leave open any hypotheſis for explaining their origin, but the conjecture; "that theſe ſingular ſuperincumbent mountains are the immediate work of ſubterraneous fire."

It is fact, that ſubterraneous fire, and its many ſucceſſive eruptions, have raiſed or heaped together the ſtill-burning Mount Ætna and Veſuvius on the limeſtone-ſtrata in Sicily and Italy [*], accumulating both theſe mountains to an elevation, and to an extent, which even ſurpaſs that of the Habichwald. It ſtill continues to work in the volcanos in Iceland; and there is no good reaſon to deny the poſſibility of other European volcanos, ſituated between Iceland and Ætna, and burning in former times. There have been found of late many extinct volcanos in Italy, ſtampt with viſible marks of ancient burning, though never ſpoken of in hiſtory. Why ſhould not Germany then, as well as Italy, afford phænomena of the ſame nature? The ſea, which covered theſe parts, as many others in the continent, will not, I hope, be alledged againſt this ſuppoſition, and thrown upon it to quench the German volcanos; ſince the ſtill-burning volcanos are generally ſituated in the midſt of the ſea, in iſlands, or near the ſea coaſt, and even ſeem to want ſea-water to raiſe, and to ſupport their very flames. It would be unfair to conclude, or to cavil any thing againſt their former exiſtence, from the ſilence of hiſtory; becauſe ten thouſand things may really happen every day, and paſs unnoticed; and German hiſtory, in reſpect to the long ſeries of former forgotten ages, begins but from yeſterday—from

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[*] Ferber's Letters.

Cæſar, Druſus, and Germanicus, our generous conquerors, or from S. Bonifacius and Charles the Great, our ungenerous apoſtles. In this light I certainly am allowed to venture that hypotheſis, which not only is a poſſible, but even ſeems to be a neceſſary ſuppoſition, ſince, beſides the above-mentioned inſufficient natural cauſes of ſuperincumbent mountains, there have been to this time no others known at all.

This ſuppoſition, like many others, might be poſſible, and ſeem neceſſary; and nevertheleſs be improbable, nay prove entirely falſe. But it has rather every quality of hiſtorical demonſtration, as ſtanding upon firm unſhaken foundations, and good authorities, which are;

1. The inner ſtructure of theſe mountains; and,

2. The nature and quality of their ſtones and foſſils.

Both agree with the nature of the Italian volcanos, which, though obſerved and deſcribed by many curious and ingenious men of every age, have not been ſufficiently deſcribed by any mineralogiſt but by Mr. Ferber.

This ingenious gentleman was, in the year 1768, when I ſaw him firſt at Caſſell, neither ſufficiently acquainted with, nor a friend to, the volcanic ſyſtem; accordingly he did not then entirely agree with my opinion. But ſince the year 1771, when he viſited Italy, he has made my opinion his own, and confirmed it by his valuable mineralogical letters on Italy, which are as good evidence for me as the Heſſian volcanos, whoſe nature I ſhall now deſcribe, and which lie open, together with Mr. Ferber's Letters, to every one, who may want ſtill fuller inſtruction, and have a mind to a nearer examination.

§ 3. *Their inner ſtructure and beds agree with the nature of volcanic hills.*

The inner ſtructure of the Habichwald, of the Dornberg, and of many hills of that kind in Lower-Heſſe, may be eaſily obſerved, wherever they are ſteep and ſhaggy, or wherever ſnow-rain- and brook-waters have laid them bare, in valleys, natural caſcades, and ravins. There is the ſame facility in ſeveral quarries, but eſpecially in the ſubterraneous galleries and aqueducts, which, on account of the famous caſcades at Wiſſenſtein, have been dug in the Habichwald, near and under the octogon of the Carlſberg.

The Habichwald, being by far the greateſt and higheſt maſs of this kind of mountains, and having been leſs degraded and changed by rain, wind, and weather, deſerves a peculiar notice in reſpect to its inner ſtructure. It ſhews a variety of accumulated vegetable mould, aſhes, clays, marles, ſands, black vitreous rocks, ſlags, and other ſtones, under different inclinations to the horizon, and in ſtrata different from thoſe which water produces, or is ſuppoſed to have produced, being never ſo exactly ſeparated from among themſelves, but commonly indiſcriminately and inſenſibly blended together, croſſing one another in their direction, and dipping on every ſide, in almoſt every ſenſe, often in parallel inclination, to the ſloping and deſcent of the mountain, often falling exactly againſt the mountain and its general direction. This ſingular poſition, nature, and variety of ſtones and ſtrata, cannot be eaſily explained by the common orological hypotheſes: but it ceaſes to be a problematical riddle as ſoon as we ſuppoſe this vaſt mountain to have been a burning volcano in former times, and to have accordingly, at different times, and by different craters, vomited ſand, aſhes, brimſtones, ſlags, and lavas.

§ 4. *No rule of ſpecific gravity to be obſerved in their different ſtrata, which are deſcribed.*

As the ſtrata of this mountain have no regular direction, dipping, and form, they are deſtitute likewiſe of any rule of ſpecific gravity. At the entrance of the Druſelthal, and at the foot of the Habichwald, to the right of the road from Caſſell to the coal mines, there is a large ſtratum of light ſpungy ferruminated aſhes, below a ſtratum of very ponderous and hard vitreous black ſtone. On the N. E. ſide of Wiſſenſtein there do appear, on the deſcent of the Habichwald, in ſeveral places, and in different elevations, immenſe maſſes of tufo in different large beds, covered at the ſummit of the mountain by heavier black ſtones. The caſtle of Weiſſenſtein is ſituated;

1. On a foundation of ſpungy friable mould or aſhes, buried behind the great baſin, which is higher up the hill,

2. Under a very heavy and compact maſs of baſaltes. [See Plate I.] Higher upwards,

3. By clay and ſand, in iſolated neſts or lumps [Plate I.]; and,

4. By great globular maſſes of black vitreous ſtone. Immediately under the octogon, at the top of the caſcades, offers,

5. A very large and extenſive ſolid ſtratum of black ſtones, whoſe broken fragments are ſcattered and ſtraggling all along the deſcent of the hill, as marked in Pl. I. Higher, and on both ſides of the octogon, follows,

6. An extenſive ſtratum of light ſpungy ſlags, which to the left of the octogon dips in the mountain, under

7. A ſtratum of heavy black rock, that runs all along the long-ſtretched ſummit to its ſteep deſcent in the Druſelthal, and the valley of Caſſell.

The ſame irregularity in reſpect to the ſpecific gravity of the ſtrata of aſhes, tufo, and lavas, is obſerved in Monte Somma, Veſuvius *, and other ſtill burning volcanos; and it is ſimilar to their irregular vomiting of aſhes, ſands, and fluid lavas.

§ 5. *Their ſtones and foſſils deſcribed in general.*

The ſtones and earths of the Habichwald, and its kindred mountains, or the ſubſtance of their ſtrata, which have been deſcribed, are,

1. Black vitreous rocks of different weight, ſolidity, and form.

2. Tarras, and flags.

3. Tufo.

4. Different ſpecies of ſtones, incloſed in the black rocks, and the tufo.

5. Aſhes.

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* Ferber's Letters.

6. Clay and marle.

7. Sand.

8. Vegetable mould. And,

9. Finally, a vaſt bed of coals, lying in a valley, gently ſloping from the very ſummit of the Habichwald, but according to many circumſtances, independent from its rocks, to which it is ſuperior, and of a more modern and different origin; for which reaſons I forbear to ſpeak of it in particular, intending only to deſcribe the nature and reſpective ſituation of the before-mentioned foſſils, which are related to each other.

§ 6. *The black vitreous rocks, found in ſolid ſtrata, ſuperincumbent on calcareous ground.*

The black rocks are called in Heſſe *Swarze-Wacken*, and would go in the mineralogical ſyſtems under the general name of horn-ſtone.

They are found either, 1. in ſolid, ſound, and coherent ſtrata; or, 2. in ſolid ridges and iſolated points; or, 3. broken and ſcattered in their ruins.

If found in ſolid ſtrata, they are now and then found immediately ſuperincumbent on the ſolid calcareous ſtrata, which I have deſcribed before as lying at the bottom of the valley of Caſſell, and of the Habichwald. They ought to be very obvious in that ſituation on the Dornberg, which up to its middle is calcareous, and at its ſummit is all over covered with fragments and maſſes of this rock. I have not, however, remarked on this mountain any place, where this ſituation might be clearly obſerved. Therefore I ſhall deſcribe two other places of that kind, which I have had the good luck to find elſewhere.

§ 7. *On the Krazenberg.*

The firſt is on the Krazenberg, in a limeſtone quarry, near an intrenchment raiſed in the laſt war over againſt Kirk-Ditmold. The calcareous beds are there running from the S. E. and the city of Caſſell to the oppoſite Habichwald; and in a line, which is parallel to this higher mountain, there goes acroſs the run of the limeſtone a large vertical vein or fiſſure (ſimilar to what the German miners would call a *gang*), which is filled with black rock. It is ſpungy and full of holes; but theſe holes are, for the moſt part, filled with white calcareous ſpar, occaſioned by the neighbouring limeſtone.

§ 8. *In a calcareous hill near* Frankenhauſen, *which is an ancient volcanic crater.*

The ſecond place here to be mentioned is ſtill more remarkable, and to be found on a ſmall limeſtone-hill near Frankenhauſen, bordering on the road from Caſſell to Carls haven. I owe its diſcovery to the penetrating look of his Excellency the Miniſter and Lieutenant General Baron de Slieffen. On the top of this hill is a conical crater, whoſe circumference is about three hundred feet. It is broken through the almoſt horizontal ſtrata of marle and limeſtone; and what is extremely ſingular, it has been on its inner ſides all around incruſtated and hanged with a covering of grey and black ſpungy rock, which, where it is broken, appears to have been one foot in thickneſs. [See Plate II. n. 1, 2.] This vitreous covering, incruſtation, or tapeſtry, hangs flat upon the borders of the crater, and before the broken reddiſh and whitiſh marle and limeſtone ſtrata. A caſt ſtucco-floor, ſunk down in a conical crater before its full petrification, would produce ſomething like this phænomenon, becauſe the black ſtony incruſtation ſticks every where cloſe to the ſides of the crater, has yielded to their inequalities, which it expreſſes by its bending bunches and concavities, and is cracked and broken in many irregular but coherent pieces. The ſame ſort of vitreous black and ſpungy rock is found at the bottom of this crater in large irregularly-ſplit maſſes, and every circumſtance cooperates to bring to mind what Mr. Ferber * ſays, in his deſcription of the Italian volcanos: "that "very often their funnels are covered but "by a thin covering or floor of indurated "lava, which often gives way and falls "down to their bottoms, probably filled "with nothing but maſſes of lava." And certainly we might not be wrong in looking upon this crater as a funnel of a ſmall volcano; 1. on account of the vitreous nature of the black rock, which covers its ſides, and fills its bottom, and will, in the ſequel, be proved to be a lava; 2. becauſe the ſtrata of reddiſh and whitiſh marle and limeſtone, to which this vitreous covering ſticks, are viſibly affected and ſomewhat calcined, by the heat of this lava; 3. becauſe a running lava iſſued from this crater, as may even yet be ſeen by its beginning within the crater, [Plate II. n. 3.] though the outſide of the hill, and the current, I ſpeak of, be entirely buried at preſent under vegetable mould, and does not appear, like many other

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* Letters, p. 149. 188.

volcanos, to be externally clad and covered by aſhes or volcanic tufo—a circumſtance, which may have been occaſioned by having been for a long time expoſed to the waſhings of decompoſing rain or inundations, or even by having been produced under the level of the ancient ſea, which I have traced before, and certainly was higher than its ſummit.

This remarkable and inſtructive natural curioſity is perhaps the only one yet known of that kind. However it is likely to be demoliſhed in few years, ſince they have begun already to remove a good deal of the inner covering of lava, for paving the Carlſhaven-road, which goes near to it; and if the Landgrave do not ſtop this demolition, as may be hoped, it will be ſoon loſt for ever. At all events, and to give it its due celebrity, I have it drawn on Plate II.

§ 9. *Theſe ſtrata, ſuppoſed to be lavas, cooled in ſubterraneous unerupted maſſes, or running erupted ones.*

The large extenſive ſtrata of the black rock under conſideration are, for the moſt part, in a nearly horizontal ſituation, and thus to be ſeen at different elevations of the Habichwald. They are beſides, without any reſpect to ſpecific gravity, in different places, now under now above other lighter ſtrata of aſhes, tufo, and ſlags. I beg leave to conſider theſe ſolid rock-ſtrata as lavas, cooled in large extenſive melted maſſes under ground, or cooled after their eruption, as large running lavas. I ſhall prove it in the ſequel. The greateſt ſtratum of this kind, or rather the moſt extenſive lava, which I had an opportunity to obſerve in theſe parts, is at the top of the Carlſberg in the Habichwald, under the foundations of the octogon. [Plate I.] Behind the grotto of Polyphemus and on its both ſides,

eſpecially

eſpecially to the right, it appears bare and open on the ſloping of the ſteep mountain. It is there about fifty feet thick. I could not diſtinguiſh from what crater it came, or where it directed its courſe, if it be at all to be conſidered as an erupted running lava. But its length or extent is at leaſt 270 German fathom, or 2170 Rhiniſh feet, this being the length of a ſubterraneous gallery, which, on account of an aqueduct and the caſcades, has been cut with great expence, and a true Roman perſeverance, through this hard vitreous ſolid rocky maſs. Its length and extent may be by far more conſiderable; and perhaps all the ſolid vitreous black rocks on both ſides of the octogon, and on the whole ſummit of the Carlſberg, together with the romantic heaps of its dreadful ruins, rolled down its ſteep deſcent into the lower valleys, might be juſtly conſidered as belonging to the ſame lava. It is covered near the caſcades with ſlags or tarras-ſtones, and theſe by a ſmaller lava or bed of black rock, which to the left of the octogon dips under ground in a direction towards the old Winterkaſten.

Thus far of the black rocks in ſolid ſtrata.

§ 10. *The black vitreous rocks in ſolid iſolated points under the level of the ſea conſidered, as remains of the former, or as nuclei of ancient volcanos.*

Their ſolid ridges and iſolated points, ſtanding free and bare on all ſides, are very common in Lower-Heſſe. Such is the Kazenſtein and the Holeſtine under the Dornberg, between Harleſhauſen and the village called Dornberg; a peak in the Widelſberg near Wolfhagen; the caſtle-hill at Felſberg; the caſtle-hill at Aldenburg; the Maderſtine near Gudenſberg, and another of that kind near the road thence to Caſſell. Moſt part, if not all of theſe bare ridges and iſolated points, are below the beforementioned level of the old ſea, and there is generally ſomething very particular in the form or breaking of their rocks, which ſhall be noticed afterwards. Having ventured to call the ſolid ſtrata of the black rocks cooled lavas, in erupted runnings, or unerupted melted ſubterraneous maſſes, a denomination which their ſituation and many other qualities will juſtify; I venture, in the ſame hope, to conſider theſe ridges and iſolated points as remains of old running lavas, or as kernels and nuclei of old volcanos, deprived by rain, ſnow, overflowing water, and a long ſeries of deſtroying centuries, of their external covering of aſhes, cinders, and ſands; which ſeems the more probable, as in their neighbourhood, and even at their feet, for example at the Holeſtine, their own ruins of black rock, and great maſſes of tufo and indurated aſhes, are to be met with.

§ 11. *The black rocks very common in ſeparated ſtraggling fragments.*

The black rocks, broken and ſeparated from their natural place, are very common in ſeveral ſteep deſcents of the Habichwald, in the Druſelthal, to the right hand of the octogon near Harleſhauſen, on that part of the Carlſberg which lies between the caſcades and the Moriz-grotto, [Plate I.] behind the Paul's hermitage, on the Dornberg, and in a hundred other places, where, their cinereous or tufo ground giving way and being waſhed of great maſſes of the ſuperior rock-ſtrata tumbled down in wild ruin, or where the before-deſcribed bare ridges and iſolated points mouldering away, were diſſolved to ruins, rolled and waſhed down into the vallies. They are in every ſituation, in ſolid ſtrata and bare ridges, as well as in their ruins, ſo very common in thoſe parts, which I have had opportunity to ſee, that generally all the roads and cities of Lower-Heſſe have no other pavement.

§ 12. *Dif-*

§ 12. *Different constant forms of the black rocks. The priſmatical ones, called baſaltes, diſcovered to be lavas.*

The *form and figure*, which they ſpontaneouſly affect when broken, is very different. I have on this account obſerved the following varieties.

1. Their form is *indeterminate* in the great lava-ſtratum on the Carlſberg, [Plate I.] as clearly appears in the ſubterraneous gallery, and in many fragments, diſperſed every where in the valleys and ground immediately under its ſteep ſummit.

2. They appear in irregular ſlates or tables, and in a vertical poſition, near the old Winterkaſten on the Carlſberg.

3. In *large globular maſſes*, compoſed by concentric and leſs compact coats, and containing in the middle a remarkably hard and compact globular nodulus or nucleus, they are obvious in a large ſtratum near the

Moriz-grotto behind the Sneckenberg, and in different other places at the Carlſberg *.

4. They are *irregular polygons*, and tending to a priſmatic columnar form, in a ſtratum behind the great baſin up to the Moriz-grotto at Wiſſenſtine, at the level with the Sneckenberg. [Plate I.]

5. In a *columnar priſmatic regular form* they appear in large maſſes or ſtrata of cloſe-lying columns in the caſtle-hill at Felſberg and Aldenburg, in the Maderſtine near Gudenſberg, in the Widelſberg near Wolfhagen, in the Holeſtine under the Dornberg, and, as I have been told, but never obſerved myſelf, in the Dornberg.

Theſe priſms or columns are of a quadrangular, pentagonal, hexagonal, and heptagonal form; flat at the top; and in the ſame ſtratum, or rather the ſame maſs of the ſame length: but, the length of theſe different maſſes being different, they differ likewiſe in length from ſix feet to twenty, and above. They have a thickneſs from ten to fifteen inches. To give an idea of their wondrous form and maſſes, I refer my readers to the engravings of the caſtle-hill of Felſberg and of the Maderſtine, which are annexed to their deſcription in the Philoſophical Tranſactions for the year 1771. Till very lately, the origin and nature of theſe ſingular ſtones was conſidered as inexplicable; but a great many correſpondent obſervations, and a nearer examination of their ſubſtance and ſituation, has, ſince the year 1768, convinced Mr. Deſmareſt[*], myſelf[†], and Mr. Ferber[‡];

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* Similar maſſes have been found by John Strange, Eſq; F. R. S. in the Euganean and Vicentine volcanic hills; their deſcription and drawings given in his account, Phil. Tranſ. vol. LXV.

a. That the ſubſtance of theſe figured priſmatical and columnar vitreous black ſtones, is to be conſidered almoſt every where* as a ferrugineous maſs, impregnated with much iron, and ſmelted by heat or fire.

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[*] Explication des Planches de l'Encyclopedie. Livraiſon cinquieme, 1768.

[†] Phil. Tranſ. vol. LXI. German Diſſertations of the R. Soc. at Goettingen, tom. I. 1771.

[‡] Letters, 1773.

b. That, appearing in priſmatical forms, it is named, by the Ancients and the Mineralogiſts, baſaltes.

c. That, in an indeterminate form, it goes in Italy under the name of lava, or ſelce and pietre dure.

d. That by refrigeration it gets a priſmatical form, as moſt part of ſmelted ores and metals get by cooling a determinate cryſtallized form in their ſubſtance †.

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* Ferber's Letters, p. 64. 272, 273.

† One of the moſt ſingular evidences of this common phænomenon happened ſome years ago at Clauſthal in the Harz-foreſt. The ſmelting of a high- or roaſt-furnace, alternately filled with coals, fluor, and pulveriſed arſenical lead, and ſilver-ore, being interrupted by accident, the ore cooled and appeared ſticking in it in large coagulated looſe and ſpungy blue-glittering maſſes, all over covered on the ſurface with quadrangular cryſtalliſations, in a form which the French call à la Grecque, unknown whether ever any where elſe produced by art or nature.

Fuller evidences of this hypotheſis ſhall be given in the ſequel.

§ 13. *Why all lavas have not a determinate regular and the ſame form?*

But why have not all our black rocks and all the Italian lavas the ſame and a conſtant determinate priſmatical form? Even the priſmatical columnar lavas or baſaltes ſhow varieties of forms. The Iriſh baſaltes in the Giants-cauſeway in the county of Antrim, appears in polygone articulate columns or priſms. There ought to be ſome natural reaſon for that, whatever it be. Is it owing to the difference of their ſubſtance and mixture? to the different ſloping of the ground on which theſe fiery melted maſſes run forward? to the different quickneſs of their motion? to their different fluidity? or is it owing rather to the manner of their refrigeration? All theſe circumſtances may, without any doubt, have influenced their different form; but our black rocks and priſmatical baſaltes being of the ſame mixture and ſubſtance, ſeem to indicate that their different fluidity, fuſion, motion, and refrigeration, have been the proximate cauſes of their before-deſcribed determinate and indeterminate forms and figures.

§ 14. *Different circumſtances under which the different mixture of lavas is known by facts, to be brought into fuſion, eruption, and cooling.*

Whatever be the cauſe of the fuſion and fluidity of the ſmelted lavas, whether it be a ſtrong heating fermentation, as ſeems highly probable, or whether it be a ſubterraneous fire, as commonly is ſuppoſed without ſufficient evidence, it is a fact, wanting no evidence, that the lavas of Ætna and Veſuvius either break their way from under ground through the lower ſides of theſe mountains, or aſcend like boiling water to the very brim of their craters, which they overflow at laſt, and thence run

down

down into the lower vallies; or that they are vomited and thrown out of theſe craters in fluid burning lumps. It is fact likewiſe, that the lavas appearing in their eruptions like fiery torrents, either overflow the continent above the ſea, and refrigerate there; or that, no eruption enſuing, they refrigerate again within the volcanos; or finally, that ſometimes, according to the ſituation of the ground, which they overflow, they run down into the ſea or other water. Nor can there be any doubt, that by ſimilar cauſes violent fermentations, fuſions, nay eruptions of ſmelted ſubſtances may be produced even at, and under, the very bottom and level of the ſea. Whoever reflects on the great number of iſlands and high volcanic hills, with boiling and ſmoaking of the ocean produced in the deepeſt ſeas, will be leſs amazed at the boldneſs and ſingularity of this ſuppoſition.

§ 15. *Hypothetical explication of the different conſtant forms of the Heſſian lavas.*

Now in all theſe different caſes, the cooling and refrigeration of the lavas muſt needs be very different.

Undoubtedly they cool ſloweſt in the holes and craters of the volcanos, where their maſs is leſs troubled by motion, and their heat leſs influenced by air and water.

They are ſooner refrigerated in the torrents, running after their eruptions over dry land, as being influenced by more cooling circumſtances of wind, weather, rain, or ſnow; ſooner ſtill, if thrown out in fluid or burning lumps; but ſooneſt and moſt violently in thoſe fiery torrents, which run into neighbouring ſeas or other waters, or even break their way immediately into the ſea.

Though I am neither inclined, nor able and willing to explain the mode by which theſe circumſtances give a different form to the hot-fluid or burning maſſes of lava, they certainly had ſome ſhare in it, as every one will agree with me, that different degrees of heat or cold, by means entirely unknown to us, viſibly influence the cryſtalliſations of ſalts. Accordingly the external circumſtances, under which the different forms of lavas are found, ſeem to entitle me to the following conjectures, relating to the different modes of refrigeration, and their influence on the maſſes of lava.

The *undeterminate forms* of the black rock or lava-ſtratum at the ſummit of the Carlſberg ſeem to be ſuch, becauſe the lava is at that place in an almoſt horizontal ſituation, which kept the whole maſs undiſturbed, and gave it an opportunity to refrigerate very ſlowly in itſelf.

The *irregular broken ſlates* laying with the former above the level of the ſea, which I have traced before, [Plate I.] at the very ſummit of the Habichwald, ſeem to belong to a lava cooled by air, and perhaps by rain or ſnow, which ſplit it, as heated glaſs cracks if ſuddenly brought in contact with cold water.

The concentric globular lumps, with a hard ſolid nucleus in their middle, are never found in a ſolid ſtratum, but here and there ſcattered about and heaped together. They ſeem to have been thrown out as fluid hot lava-maſſes, and falling through the air, and rolling on the deſcent of the mountain, to have acquired a globular form. The ſuppoſition that their external coats, ſuddenly cooled by the ambient air wherein they moved firſt, and that they were rolled afterwards over beds of aſhes and ſmall volcanic ſtones, which commonly cover the ſides of the volcanos, accounts very well for their hard nodules, which, unaffected by the air, cooled ſlower. It accounts likewiſe for their external cracking and breaking into concentrical ſcales, which are of a leſs compact ſubſtance, reſembling

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rather aſhes ferruminated with ſmall volcanic ſtones. The origin of the phialae Bononienſes and cracking glaſſes is in ſome reſpect like to this hypotheſis; and Mr. Ferber * gives nearly the ſame explication of the ſame phænomenon in Italy.

§ 16. *The* Heſſian *and many other priſmatical baſaltes appear in or under the level of the ſea, and ſeem to be lavas cooled by or under it.*

The *regular priſmatic columnar black rocks or baſaltes* ſeem, according to their ſituation and quality in this country, and in many others, to be lavas, which in a hot-fluid ſtate broke their way from under ground immediately in the ſea, or run into it, or cooled under its level, without any eruption, within the ſtrata, caverns, and holes, wherein they had been brought to fuſion.

1. All our Heſſian baſaltes, which I have examined, are viſibly under the ancient level

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* Letters, p. 278, 279.

of the ſea, which I have traced before. [Plate I.] This remarkable circumſtance is evidenced to conviction, by a large bed of lava, which is throughout inclining to a priſmatical form, and is ſituated immediately under the Moriz-grotto at Wiſſenſtine, exactly at the level with the Sneckenberg, which contains a ſtratum of calcined littoral ſhells. [Plate I.] The caſtle-hills at Felſberg and Aldenburg, together with the Maderſtine near Gudenſberg, are undoubtedly below the ſame level.

2. Above this level I never have found, neither on the Habichwald nor on the Dornberg, any priſmatical baſalt-maſs. Theſe facts agree with the following in other countries.

3. The Iriſh baſaltes in the Antrim Giants-cauſeway, which are articulate priſmatical columns, together with thoſe of the ſame kind, which Mr. Banks has of late diſcovered in the iſland Staffa *, are ſituated

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* Pennant's Voyage to the Hebrides.

near or even in the marine level, nay far ſtretching into and under the ſea. Thoſe at Dunbar in Scotland * are in a ſimilar poſition; and the gigantic baſalt-pillars near Langaneſs in Iceland, which are nine feet diameter, are continually waſhed, and for a great part overflowed, by the ſea †. Ronca, a hill in the Veroneſe territory near the Valle del Buſo, conſiſts of alternate marine and volcanic productions, among which a bed of black lava ſplit in priſmatical forms clearly appears to be covered by a calcareous ſtratum filled with a variety of marine petrifications ‡, which greatly countenances my opinion. Bolca, a hill, likewiſe in the Veroneſe, is of the ſame mixed marine and volcanic kind, conſiſting in its ſummit of calcareous ſlate, famous for its fine petrifications of marine fiſhes, and covering an immenſe variety of lavas and other volcanic productions ‖. The priſmatic baſaltes near

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* Pennant's Tour to Scotland.

† Drawings in Mr. Banks's collection.

‡ Ferber, p. 53.

‖ Ibid. l. c.

Bolzena, between Monte Fiaſcone and Aquapendente in the Roman State, are nearly in the level of the lake of Bolzena *.

4. The moſt exact obſervers of Veſuvius, Sir William Hamilton at Naples, and Mr. Ferber, have never met with any priſmatical lava or baſaltes in its many old and new erupted lavas, which cooled in the continent, and above the ſurface of the ſea; nor do I remember to have found them mentioned in Sir William Hamilton's, or other deſcriptions of the gigantic Ætnean lavas, which like large rivers have overflowed the land.

§ 17. *This hypotheſis recommended to further examination in* Sicily, *and ſome new volcanic Iſlands in the* Archipelago.

However, I recommend this ſingular phænomenon, and my bold hypotheſis, to the examination and judgement of Meſſrs. Deſmareſt, Fortis, Born, Ferber, Sir William Hamilton, and Mr. John Strange, as the moſt competent judges, hoping that if the cooling under ground and the ſea level, or in ſea or other water, has really had any ſhare in the priſmatical form of baſaltes or lavas, more evidences of it ought to be found in many volcanic iſlands, but eſpecially in the too-much neglected new raiſed iſlands of the Archipelago [*] and in the large Sicilian lavas, which near Catania and many other places reached the ſea.

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* Ferber, l. c. p. 281.

§ 18. *Deſcription of the* Heſſian *Lavas, and their compariſon with the* Italian *ones.*

Whatever I have hitherto ſaid concerning the ſituation and the forms of our black vitreous rocks, as of refrigerated lavas, is but hypothetical. Therefore the queſtion naturally ariſes: whether this may be confirmed by their nature and by their compariſon with true lavas? and whether our black vitreous rocks, baſaltes, and the known lavas, be one and the ſame ſort of ſtones, and accordingly of the ſame origin? Every one of my readers has full right to put this queſtion to me, who, unſatisfied by hypothetical ſolutions, chooſes rather to *ſee* than to *hear*. Whoever has no opportunity to convince himſelf by ocular inſpection, may be convinced by Sir William Hamilton*, and by Mr. Ferber†: "that "lava and *moſt part* of the priſmatic baſaltes do not differ in themſelves, but "only in their forms:" and I deſire theſe gentlemen to believe me on my word: that our priſmatical baſaltes at Felſberg and elſewhere are, on account of their colour, ſubſtance, and mixture, of the very ſame maſs as our hardeſt black and grey rocks, which have all the qualities of many Italian and other lavas, and which, together with the baſaltes, for that reaſon, I not only henceforth ſhall conſtantly call lavas, but preſently deſcribe, with convenient exactneſs, an account of their various inner qualities. I would not however be charged with the imputation as if I did, without exception or proper allowance to facts, declare every ſort of black vitreous rocks, together with every ſpecies of their kindred hornſtone-rocks and priſmatical baſaltes, to be produced by ſubterraneous extinct fire or fermentation. I am convinced by facts and led by good authority to preſume, that Nature works ſimilar effects by different cauſes. It is but lately that I have learned by Mr. Ferber, though in the main he be of my opinion, that there are ſome ſcarce ſpecies of baſaltes, which ſeem to have been produced by water *, and that there are at Wilkiſhen in Bohemia, as in different other places,

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[*] In the year 1763 deſcribed and recommended to philoſophical obſervations in my *Specimen hiſt. naturalis de novis inſulis. Amſtelodam.*

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* See his letter of Dec. 12, 1769, which he did me the favour to write from Naples, inſerted in the German Diſſertations of the R. Soc. at Goettingen, vol. I. p. 92.

† Letters, p. 65, 66. and 270.

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* Letters, p. 272.

rhomboidal clay-ſlate and granite columns, which owe their cryſtalliſation to water [*]. I intend here only to ſpeak of our black rocks, which in themſelves and through all their varieties ſhow inconteſtable marks of fire and fuſion, are undoubtedly nearly related to our baſaltes, and reſemble the Italian and other lavas.

§ 19. *Their different colours.*

Our lavas are like the Italian ones, which Mr. Ferber has ſo ſcientifically deſcribed in his Letters [†], of a different colour, ſolidity, weight, texture, and appearance, according to their different mixture, to their degree of fuſion and combuſtion, and to their refrigeration.

They are of a black, black-grey, aſh-grey, and reddiſh brown and ferruginecous colour.

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[*] Mineralogical Account of Bohemia, German edit. p. 122. 125.

[†] P. 175.

The two former ſorts are moſt frequent. The baſaltes at Felſberg, Aldenburg, and Maderſtine, are black or black-grey.

The aſh-grey coloured are in different ſhades to be found in the high borders of a deep rivulet near a village called Bodiger, and in diſperſed ſtraggling fragments between Upper-Vilmar and Burg-Uffelen.

The reddiſh and brown-coloured are very ſcarce, and but in ſtraggling pieces and fragments to be found at the foot of the Holeſtine under the Dornberg. This and the aſh-grey ſpecies I never have happened to find completely ſolid, ſound, ponderous, and in a priſmatical form; whence it ſeems to follow, that they have been in a ſtate of conflagration, which ſuppoſes an eruption, and has greatly leſſened their weight and ſolidity.

§ 20. *The black and black-grey coloured are the ſoundeſt and hardeſt; appear in different conſtant forms; and ſeem to have been but in a ſtate of fuſion.*

The black and black-grey lavas, which are the ſoundeſt, hardeſt, and heavieſt, are probably ſuch lavas as have been juſt in a ſtate of perfect fuſion, and cooled within themſelves, or on a ſudden. For this reaſon and on account of their priſmatic-columnar, concentric-globular, ſlate-like or undeterminate forms, they ſeem to be different from thoſe which, having been in a ſtate of eruption and conflagration, never offer any ſuch regular form or ſound ſolidity. They are generally ſuſceptible of a fine poliſh, and withſtand for many centuries the action of wind and weather, and even exterior violence in the public roads. Though extremely hard and compact, they are however but ſlowly diſſolved or affected by air, ſince expoſed to it for many centuries they get a white-greyiſh colour, which now and then is found penetrating for a tenth part of an inch into their harder and deeper-coloured inner ſubſtance.

§ 21. *Their ſubſtance, which is vitreous, contains different ſpecies of ſherl.*

Their ſubſtance is a fine maſs, without any viſible grain; vitreous, but without any remarkable gloſs on the fractures. It is ſcarce if ever entirely pure, homogeneous, and of the ſame mixture or colour, being more or leſs mixed and internally blended.

1. With deeper-coloured ſpots of the ſame ſubſtance;

2. With ſmall whitiſh, green, and blackiſh, often ſcarce viſible glaſs or ſherl ſparks or flakes;

3. With larger maſſes of mixed white, yellow, green, and blackiſh cryſtallized

ſherl, commonly appearing in the form of blunted larger pebbles;

4. With black lamellated ſherl; and now and then, but very ſeldom,

5. With yellow, deep graſs-green, and black vitrifications, harder than flint.

The ſounder and harder black and grey lavas of Veſuvius, deſcribed by Mr. Ferber[*], are generally of the ſame mixture as theſe under conſideration, except that they contain a greater quantity of ſherls in larger cryſtals, and in a greater variety of determinate forms[†], and that they never contain any of the above-deſcribed mixed cryſtallized ſherl-maſſes, Nº 3.

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[*] Letters, p. 164. 167.

[†] Such as a polygone, globular, garnet-like, and hexagonal pointed or truncated columnar, and other forms.

§ 22. *A new ſpecies of cryſtallized ſherl-maſſes, not to be confounded with granite or granitello.*

Here it may be queſtioned: "whether "theſe pebble-like mixed cryſtallized ſherl-"maſſes of our harder lavas, may be at all "ranked amongſt the ſherls? or, whether "they be a particular undeſcribed ſpe-"cies?"

When I firſt attempted an examination of our baſaltes and lavas, I was very uncertain what to make of theſe maſſes. According to external appearance, which in mineralogical objects is hardly ever to be depended upon, I conſidered them as a ſpecies of granite fragments, which I ſuppoſed to be thrown out with the lava *; but as they are really deſtitute of the quarz, feldſpath, and mica-particles, the eſſential ingredients of granites *, I readily gave up this erroneous opinion, and declared them in the year 1768, when I was acquainted with Mr. Ferber, and on his authority, to be a tin-ore, ſimilar to a ſpecies of zinn-

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* See my account of the Heſſian baſaltes, in the German Diſſertations of the R. Soc. at Goettingen, tom. I.

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* I know very well that ſome Italians call granitello the ſpeckled and coarſe ſubſtance of the baſaltes in Monte Roſſo, which is exactly reſembling that of the large baſalt-pillars near Langaneſs in Ireland, as may be ſeen in Mr. Banks's collection, and even has ſome likeneſs with the granite-like Heſſian ſherl-maſſes; *ſed verba valent ſicut nummi*; and I could wiſh to ſee the pretended Euganean columnar or other granitello chemically and cloſely examined by ſo excellent an obſerver as Mr. John Strange, in order to give into the hypotheſis (Phil, Tranſ. vol. LXV. part I.), and conſider this granitello as a granite, and the Monte Roſſo columnar baſaltes as a granite-bed melted and cryſtallized locally, or in *ſtatu quo*. Monte di Diavolo near S. Giovanni Harione is, according to Mr. Ferber's account (Letters, p. 66), as many other baſaltine and lava-maſſes, ſuperincumbent on calcareous ſtrata; and granites have never been found inferior to them, being beſides ſubſtantially different from the volcanic ſherl-concretions which I was ſpeaking of, and which ſeem to be common in the Monte Roſſo baſaltes.

wald in Bohemia *. However we were equally wrong in this conjecture, which I have been convinced of by ſeveral chemical aſſays, by a cloſer examination of their matrix and its concomitant circumſtances, but eſpecially by Mr. Ferber's late deſcriptions of the Italian ſherl and lava ſpecies.

Theſe mixed cryſtallized ſherl-maſſes agree with the known ſherls in their melting very eaſily by the blow-pipe, and in their giving to the borax-glaſs a deep green colour. They do not contain any tin. Though congealed in ſmaller cryſtals than the common Italian lava-ſherls, they are found accompanied by unequivocal lamellated ſherls, incloſed in the ſame maſs of lava or baſaltes. Like the Italian larger ſherl-cryſtals they diſſolve in the air, and moulder in an ochraceous, ferrugineous, argillaceous powder. Accordingly, they are to be conſidered; " as a particular un-

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* L. c. and deſcribed by Mr. Ferber in his mineralogical account of Bohemia, p. 132.

“ deſcribed ſpecies of ſherls, peculiar to “ our Heſſian lavas or baſaltes *.” If theſe ſherl-concretions be found incloſed in the ſounder and harder lavas or baſaltes, they are tolerably compact and remarkably ponderous; take a poliſh inferior to that of their lava- or baſalt-matrix; an indifferent poliſh to be had on their yellow and faint-green cryſtals, but a ſplendid one on the black and dark-green ones, which are remarkably hard, and ſtrike fire with ſteel. Sometimes they are found in tufo, ferruminated in aſhes with different ſtones and lava-pieces, which appear to have been thrown out by volcanic eruptions, and then they are obſerved to be ſometimes wrapt up in a maſs of ſpungy, ſlaggy, and burnt lava; which ſhows them to have been thrown out with this burning lava from the

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* It is ſprinkled, but in ſmaller patches and lumps in the Langaneſs baſaltes in Iceland, in Mr. Banks's collection, and it ſeems to be common in the baſaltine maſſes of Monte Roſſo, as deſcribed by Mr. John Strange.

deeper volcanic funnels, and to have been either in a ſtate of fuſion, or covered with burning lava lumps.

§ 23. *Queries concerning the origin and nature of the volcanic ſherls.*

They never have offered themſelves to me in our tarras or thoſe lavas that have been ſcorified, though they very often contain a brittle and gloſſy lamellated ſherl. This remarkable circumſtance naturally occaſions the following queſtions:

1. Whether the ſubſtance of theſe mixed white, yellow, green, and black ſherl-maſſes, be the fixed phlogiſton of our lavas and baſaltes?

2. Whether this phlogiſton be congealed into cryſtalline lumps by the ſuffocation or cooling of the fluid lavas? or,

3. Whether theſe maſſes, whoſe ſubſtance is by fuſion thoroughly mixed with the

maſs of the Italian and our lavas, be found in the deepeſt volcanic rocks and funnels as peculiar pre-exiſtent rocks, or be produced and incloſed like pebbles in the cooled lavas of former times?

4. Whether they be thrown up, melted in the fluid lava, and by the intenſeſt degree of heat, which conſumes even lavas to ſlags, they be volatiliſed either wholly or in part, or changed and vitrified to glaſs-frittas and brittle and lamellated ſherls, ſuch as are found not only in the ſounder, but likewiſe in the ſcorified, lavas and baſaltes?

There is no circumſtance to warrant the ſuppoſition of their having been like other paraſitical ſtones generated and cryſtallized by water in holes and bladders of ſolid lava; but future chemical aſſays will certainly throw light on theſe queries, and demonſtrate the origin of lavas and of theſe and other ſherl-ſpecies, which Mr. Ferber is inclined to aſcribe to ſubterraneous fire.

§ 24. *The*

§ 24. *The vitrifications in the hardeſt lavas deſcribed.*

The *vitrifications* or *frittas* of our lavas ſeem to be of the ſame ſubſtance as the ſherl-maſſes, ſince they ſtick to the ſame volcanic matrix, and have the colour of their dark-green and black cryſtals, and of the lamellated ſherl; but they are remarkably harder, ſtrike fire with ſteel, cut glaſs, and might with juſtice be ranked among the precious ſtones. They are of a deep graſs-green, a yellow, and a black colour.

§ 25. *The green vitrifications a new ſpecies of precious ſtones.*

The *green ones* are of a deep graſs-green hue, have a pebble-like blunt form, and are as it were caſt in the maſs of lava or baſaltes. Their hardneſs is remarkable; reſiſts the Engliſh file, and requires in grinding and poliſhing the ſame art as the hard-

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eſt precious ſtones, according to the trials and evidence of the court-jeweller Heſs at Caſſell. But it is pity that they are ſo ſcarce, and commonly cracked and ſplit. Elſe their fine colour and hardneſs would entitle them to be ornaments of the rich, as well as other ornamental coloured natural glaſſes, which on no better account have been ennobled by prejudice and ſuperſtition; and if they ſhould be found deſtitute of their fabulous magic craft, they certainly would not appear to be as reſplendent and as electrical.

§ 26. *The black vitrifications known by the Ancients.*

The *black vitrifications* or *frittas* are to be found in as undeterminate forms. However, I have a ſpecimen in a pyramidal form, with blunted angles externally rifled like priſmatical or ſtangen-ſherl. Their inner texture is now and then ſimilar to that of the lamellated ſherl, but they are much harder. The Ancients knew theſe vitrifications under the name of *petræ obſidianæ*. They have a fine black colour; and on account of their hardneſs, which ſtrikes fire and reſiſts the file, they take a fine poliſh.

Though I have likewiſe found in our ſolid lavas and baſaltes *yellow vitrifications* like topaz, they never occurred to me in a ſize ſufficient to aſſay their hardneſs, poliſh, and other qualities.

All theſe vitrifications offer themſelves likewiſe in the Vicentine and Veſuvian lavas [*], though on account of form their ſherl-ſpecies are different from ours.

§ 27. *The ſpungy lavas never appear in any regular form; and ſeem to have been erupted running lavas.*

So much of our ſolid lavas and baſaltes, and their admixed coæval ſtones. I proceed to a ſecond ſpecies, to the *ſpungy*,

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[*] Ferber, p. 173.

ſkimmy, and honey-comb lavas, whoſe nature gives viſible evidence of their fiery origin. They never have offered to me in a priſmatical-ſlate or concentric nucleus form. I have found them immediately laid on the limeſtone-ſtrata, and commonly in ſtraggling fragments; but never in ſound ſtrata. Where they appeared ſtratified and coherent, they might be ſuppoſed belonging to erupted lava-torrents. Mr. Ferber *, ſpeaking of the ſlaggy Veſuvian lava, ſays: "that "during the eruptions, it runs out of Ve"ſuvius with violent ebullition and ſkim"ming, which by means of the incloſed "air produces its various-ſized holes and "bladders, and makes its ſuperficies very "porous." On this authority our ſpungy honey-comb lavas are to be aſcribed to neighbouring volcanic craters, or to the ſurface of lava-torrents; and in fact, they are found in the above-mentioned calcareous crater near Frankenhauſen, [Pl. II.] and on both ends of the gallery, or the large lava-bed on the Carlſberg. [Pl. I.] Their maſs, mixture, the glaſs and ſherls in them, are the very ſame as thoſe in the ſolid lavas, from which they differ in nothing but, 1. the want of a priſmatical or other determinate form; 2. their leſſer weight; and, 3. their air-holes. I have found the following varieties.

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* Letters, p. 173.

1. A black ponderous ſpecies with round holes, in ſtraggling pieces in the Druſelthal.

2. Of the ſame colour, ſtraggling under the Holeſtine on the Dornberg, with lengthened irregular holes.

3. A black ſpecies in the inner part ſcorified and burnt, but externally ſolid though ſlaggy. Frequent in tufo; to be more minutely deſcribed afterwards.

4. A grey ſpecies, with large air-holes, diſperſed on the public road between Upper-Vilmar and Frankenhauſen.

5. Another grey ſpecies, to be found in the calcareous crater near Frankenhauſen. Its air-holes ſmall.

6. Another grey-coloured, with ſmaller holes, in the limeſtone-quarry on the Krazenberg, deſcribed before.

7. A black ſort from the lava-bed and the gallery under the octogon on the Carlſberg.

8. A whitiſh-grey, ſandy, coarſe ſpecies, from the borders of a rivulet near Bediger, with large round bladder-holes.

9. A reddiſh friable; and,

10. A red browniſh ſolid but ſcarce ſpecies, with large holes, under the Holeſtine on the Dornberg.

§ 28. *They contain in their holes ſeveral paraſitical aqueous, calcareous, and horn-ſtone congelations.*

The air-holes or bladders of all theſe lavas are ſeldom found empty, being commonly filled with ſtones and earth, which have been depoſited and congealed therein by ſteams or water, and for this reaſon are of a more modern date than their lava-matrix. You meet often with ſuch holes, which have been but partially filled and incruſtated; and ſome there are, in which theſe congelations have diſſolved and have almoſt diſappeared. The red and brown ſpecies, 9. 10. have their air-holes ſlightly incruſtated with ochraceous and brown iron-duſt. The whitiſh-grey from Bediger, n. 8. contains ſome empty bladders, ſome coloured with brown iron-duſt, ſome filled with glaſs kopf or button-ore. The holes of the black and grey ones are generally filled with white, and ſometimes cryſtallized calcareous ſpar; but in the ſpecies n. 1. and 2. from the Druſelthal and the Holeſtine, they are incruſtated with a white milk-coloured, opaque, hard and thin cruſt, which ſeems to be flinty and vitreſcent, ſince it reſiſts the action of acids.

§ 29. *Of the* Vicentine *achates enhydros, and the* Iceland *chalcedonies, produced in volcanic matrices.*

Perhaps Nature intended here to produce chalcedony by the ſame way as it generates this fine ſtone in the volcanic aſhes and tufo near Vicenza*, or in ſimilar volcanic matrices in Iceland, whence lately have been brought ſtratified large chalcedony-maſſes, equal in goodneſs, but far ſuperior in bigneſs, to thoſe of the Eaſt-Indies *. I have in my collection of foſſils ſpecimens of theſe chalcedonies, which convince me

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* Ferber, p. 21. They are found in nodules, which ſometimes are hollow within, and filled ſtill with the water that had produced them. A very remarkable phænomenon! They are known in Italy under the name of *achates enhydros*, and the grain of chalcedony and agathe is certainly not to be diſtinguiſhed. Abbé Fortis at Venice gave me the following account of them in a letter of January 18, 1772. "L'Achate enhy- "dros, que je vous ai envoyé, ſe trouve dans la pierre "brune

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" brune volcanique dont je vous ai auſſi fait paſſer un
" échantillon. On la trouve dans une colline prés de
" Vicence, qui donne auſſi ſur le ſommet & tout au-
" prés de cette pierre même des corps marins en pierre
" calcaire. Vous ne me demanderez plus à quel prix
" cette curioſité eſt chez nous lorſque je vous aurai dit,
" que c'eſt moi même qui les trouve & les fais travail-
" ler. On a deux ou trois pour cent globules d'Achate,
" qui ayent de l'eau; & on ne trouve pas quatre pour
" cent entre ceux qui en ont, dont on puiſſe faire
" uſage."

* As the court-jeweller Mr. Heſs wanted large pieces of chalcedony to finiſh the proſpect of Rhinefels in Florentine-Muſaïco or pietre commeſſe, which by order of the court has been undertaken many years ago, and will be when finiſhed one of the moſt remarkable pieces of workmanſhip of that kind, I procured them from Copenhagen by Mr. Danz at Blankenburg near Saalfeld, one of our beſt merchants for natural curioſities.

that their matrix is a ſort of volcanic tufo, and that accordingly chalcedony is henceforth to be conſidered as a paraſitical ſtone or concretion in volcanic aſhes or lavas. Who ever thought of that in former times! and who for that very reaſon can help wiſhing that henceforth the too-much neglected lavas and volcanic productions, and eſpecially their paraſitical concretions, might be ſubjected to a cloſer examination?

The lavas hitherto deſcribed ſeem, on account of their external appearance and circumſtances, to have been juſt in a ſtate of fuſion; and their weight and ſolidity give ſome hopes that a proper chemical analyſis will determine their conſtituent parts, and ſhow out of what ſpecies of metals, ſtones, ſalts, and earths, the great chemical fire of Nature did prepare and melt them. Mr. Sauſſure at Geneva, and Mr. Erxleben at Goettingen, have propoſed to undertake theſe aſſays, and undoubtedly their pains will not be unrewarded.

§ 30. *The burnt and ſcorified lavas deſcribed in general.*

The *burnt and ſcorified lavas* have undergone different degrees of combuſtion. Though coloured like thoſe before-deſcribed, which have been but juſt in a ſtate of fuſion, they have loſt, by longer and intenſer heat, and perhaps by their own conflagration, their ſolidity, hardneſs, and weight. They are changed either to ſlaggy light ſtones, or to different ſorts of aſhes. The former, I mean the ſcorified ſtones, are found either mixed with aſhes and other ſtones ferruminated into volcanic tufo, or in a large ſtratum near the octogon on the Carlſberg, which conſiſts of ſpungy light tarras-ſtone.

§ 31. *Appear incloſed in tufo.*

The *burnt lavas contained in tufo* have been leſs conſumed by fire, being black or grey lumps, whoſe harder and ſpungy outſide ſhows ſtill the common ſherl-ſpots, maſſes, and vitrifications; but in the inner parts they are ſo exactly reſembling iron-ſcoria, that nobody can poſſibly doubt their former fluidity and burning. They have been perhaps thrown out in burning lumps, extinguiſhed by the aſhes in which they fell, but internally conſumed by continued intenſe heat and glowing.

§ 32. *The tarras-ſtone, a ſcorified lava, deſcribed.*

The *tarras-ſtones* are as cinders throughout ſcorified, burnt, ſpungy, and accordingly very light. They reſemble the ſmall reddiſh cinders in the Roman-Puzzolana, though theſe commonly be leſs ſpungy; but they are entirely ſimilar to the tarras-ſtone from Bockenhime and Andernac, which are very well deſcribed and chemically analyzed in the Magazine of Hanover, Nov. 21, 1774. They are found in a large ſtratum near the octogon ſuperincumbent on the large ſolid lava-bed. The ſurface of the running lavas is very ſimilar to its nature. P. La Torre, giving an account of the Veſuvian eruption in 1731, ſays: "As the "lava advanced, a great many ſtones tum-"bled from its ſurface. It was covered all "over with ſtones, which were either in "their natural ſtate, or calcined and re-"ſembling burnt tiles or iron-ſlags. Their "gravity was very different." The former fluidity of our tarras-ſtones or ſlags appears on their ſurface, and in their form, which is extremely various, and ſometimes reſembling to rifled coral-branches. Mr. Ferber found, on the inner ſides of the crater of Veſuvius, a lava which had the ſame form *. Their ſurface is covered and ferruminated ſometimes with ſmall volcanic ſtones; but nothing proves their ancient fluidity more clearly than their ſpungy ſubſtance and air-holes. Their colour is ex-

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* Letters, p. 176.

ternally grey, red-brown, or ochraceous, and ſeems to be occaſioned by water ſoaking through the ſuperior beds of mould or lavas, incruſtating them with diſſolved aſhes, clay, and red ochraceous ſtalactites. If broken, the fracture is grey or black, like the colour of the ſolid lavas, from whence they ſprung. They never contain the cryſtallized ſherl-maſſes of the ſolid leſs conſumed lavas; but ſometimes they offer a reſplendent brittle lamellated ſherl in black ſparks and a thick-lamellated ſpar, which does not efferveſce with acids, and appears but very ſeldom.

§ 33. *The volcanic aſhes of the* Habichwald.

The *aſhes*, being the remains of the conſumed lavas, tarras-ſtones, or ſcoriæ, are thrown out by the volcanos either pure, or mixed with different ſorts of ſands and ſtones, affected or unaffected by fire, fluid, or burning; which, according to their different mixture, cauſes different beds of aſhes, that are ſomewhat reſembling to the aqueous or ſubmarine ſtrata, as appears on Veſuvius, and in the tufo-quarries on the Habichwald.

Theſe aſhes, being firſt looſe, muſt needs roll and ſlide down from the ſummit of the volcanos, if they be ſteep, or they might be waſhed down by rain-water into the adjacent vallies. By ſuch accidents the cities of Herculaneum, Pompeia, and Stabiæ, have been entirely buried; and for ſimilar reaſons we find our volcanic aſhes on the foot of the Carlſberg ſtill looſe and pure in the flat ground, on which the Sneckenberg and the caſtle of Wiſſenſtine are built. They could not remain on the volcanic ſummits in their firſt beds, but where they found horizontal grounds. Accordingly they appear in large horizontal ſtrata in the tufo-quarries on the Habichwald behind Paul's-hermitage, in the Druſelthal, and at the ſummit of the hill above a ſmall village called *Hof*.

I have obſerved the following varieties of aſhes.

§ 34. *A ſtratum of blueiſh aſhes contains ſome walker-clay, which confirms Mr.* Beaume's *theory on the origin of clay.*

A blue-grey and friable ſpecies ſtands in a horizontal bed under the palace of Wiſſenſtine and the Sneckenberg, as [Pl. I.] can be obſerved every where, eſpecially in the terraſes under the palace and under the bowling-green in the gardens. Theſe aſhes are pure, without any mixture of other volcanic ſtones, perhaps becauſe they had been ſituated under the level of the old ſea, [Pl. I.] and waſhed by it or been brought down from the mountain by rain- and ſnow-water. This ſpecies does not efferveſce with acids, and is friable to an impalpable powder, for which reaſon it cannot be ranked amongſt the finer ſands. In open air or in water it diſſolves and melts without any coherence, for which reaſon it cannot paſs for clay. It conſiſts of fine grey and black points, and is mixed with ſome fine talc or mica flakes, as appears by the microſcope. Its elixiviation properly evaporated gives ſome ſalt, which for its effervеſcence ſeems to be alcaline. The ochraceous ſediments of the waters ſpringing from or ſoaking through this ſtratum indicate ſome vitriol and iron, and its ſulphureous ſmell the preſence of a ſulphureous acid, which probably occaſions in this ſtratum ſome phænomena ſtrongly confirming Mr. Beaume's theory and experiments on the origin of clay, as produced by vitreous earth ſaturated by ſulphureous acid. The phænomena I am ſpeaking of, are great lumps of a fine tough walker-clay (*Wallerii*, Spec. XXIX.) and ſtraggling marle-nodules, both now and then incloſed in this cinereous ſtratum without any mark of their being adventitious to the place.

The *walker-clay* is of the colour of the aſhes, but ſomewhat ferrugineous. It moulders in open air into lamellated ſlates,

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and acquires an efflореſcence of the ſame ſalt, which by elixiviation can be extracted from the aſhes. Its particles are fat and ſaponaceous to the touch, getting by rubbing a poliſh on the fractures. They effervеſce with acids, which may be owing to the mixture of the alcaline ſalt.

The *marle-nodules* reſemble the ludi helmontii, and ſplit into ſcaly pieces, commonly joined together by a cryſtallized yellow ſpar: but the leaſt exterior violence ſeparates them again, and then the incruſtations of theſe ſcaly pieces appear like fine yellow velvet, ſpotted here and there with pyrites. Their effervеſcence with acids is not only an evidence of their having been produced by the before-deſcribed walker-clay, but likewiſe of an admixed alcaline ſubſtance.

§ 35. *Several*

§ 35. *Several other ſpecies of volcanic aſhes.*

Whitiſh-grey aſhes friable and extremely light, are found above the tufo-beds behind the Paul's-hermitage at Wiſſenſtine. They are mixed with fine lava-ſand and ſherl-points, of a white, yellow, ferrugineous, and black colour. They reſiſt acids.

A *blue ſpecies* equally friable and mixed with black ſherl-points, is found in the ſame place.

Grey and *brown-coloured aſhes* mixed with a great number of ſmall volcanic ſtones, cinders, and lamellated ſherl, reſiſting acids, are found in a large bed in the Druſelthal underneath the Habichwald.

Future enquiries may perhaps diſcover more ſorts of aſhes in theſe volcanic countries, nay there is ſome probability that ſeveral earth- and clay-ſtrata in the vallies about the Habichwald and Dornberg are owing to aſhes in ſome places changed by ſulphureous acids. The coal-ſtratum on the ſummit of the Habichwald may be perhaps aſcribed to the ſame cauſe as being in a great many reſpects different in its nature and ſituation from other coal-beds. But not having yet fully examined theſe objects, I cannot ſupport this conjecture, except by Mr. Ferber's ſtriking confirmation of Mr. Beaume's theory on the origin of clay, and by his remarkable account * of the ſolfatara near Naples, and the alum-works at Tolfa in the Roman dominions. The ever-working ſulphureous acid has in theſe places not only changed volcanic aſhes and lavas into clay, but even imparted to it an aluminous nature †.

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* Letters, p. 187. 243.

† The ſame may poſſibly have happened in the famous coal-pits on the Wiſſener, in the remarkable clay-pits and in the rich alum-works near Allmerode in Heſſe. I have obſerved in theſe parts a great many

§ 36. *Tufo is produced by ferruminated volcanic aſhes.*

Volcanic aſhes, if pure and ferruminated, have produced the above-deſcribed cinereous friable ſtones; but thrown out or waſhed together with various ſtones, affected or unaffected by fire, fluid and inflamed, they have produced the large and various tufo-beds, which according to Mr. Ferber's letters (p. 144, 145, 146,) are frequent in the neighbourhood of volcanos, becauſe they hardly ever ceaſe to throw out

ſtones reſembling thoſe of the volcanic Habichwald, ſuch as lime- and ſand-ſtones, and harder lava-pieces; and in the ſame tract of land, that is to ſay, between the Fulde and Werra, I have examined eighteen years ago a coal-pit and alum-work belonging to Baron Hanſtein, and ſituated on the Steinberg near Munden, where the alum was extracted by elixiviation from the clay and the aſhes of brown coals or foſſil-wood, which was found there unpetrified and greatly impregnated with pyrites and ſulphur. The coals of the Wiſſener are of the ſame kind.

aſhes and ſtones. The Pauſilippo and other hills near Naples are only large heaps of ſuch tufo, which ought to be carefully diſtinguiſhed from the different calcareous tophus or oſteocolla precipitated by water. Strata of this cinereous tufo are very common round about the Veſuvius. Herculaneum, Pompeja, and Stabiæ, are buried under them *; and the Habichwald in its whole and vaſt circumference is but an accumulated heap of alternate tufo and lava, as appears by the frequent large and horizontal tufo-beds between the Druſelthal and the palace of Wiſſenſtine, behind Paul's-hermitage in the gardens belonging to it, but eſpecially by the quarries on the ſummit of the mountain near Hof, and in many other places. The Dornberg was of old likewiſe clad with tufo, as appears by its large maſſes and lumps ſcattered at its feet near the Holeſtine, and in different other places of its vaſt extent.

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* Ferber, p. 145. 184. 186.

§ 37. The

§ 37. *The ϖόρος of the ancients, and uſe of tufo.*

The ancients employed tufo in the walls and vaults of their buildings *, but if the late Abbé Winckelmann by the authority of Pauſanias (lib. v. c. 10.) intended to prove, that the temple of Jupiter at Elis was conſtructed with tufo, he certainly was wrong, becauſe the ϖόρος, which Pauſanias ſpeaks of, was, according to Theophraſtus de Lapidibus, on account of its colour and ſolidity, like the Parian marble, which bears no reſemblance at all to the volcanic tufo.

§ 38. *The volcanic tufo employed in buildings.*

There is no doubt that the ancient inhabitants of Italy employed this ſort of ſtone in the inner maſs of their walls and in their larger buildings *. Even the preſent inhabitants have not diſcontinued that practice, which is equally in uſe in ſome parts of Germany, becauſe this ſtone is very common, very eaſy to be cut into convenient forms, to be found in large pieces, and never cracked and ſplit. The famous caſcades, grottos, and the octogon at Wiſſenſtine, ſtupendous works, which would bear a compariſon with the gigantic vaſt Egyptian buildings, and the greateſt pieces of architecture of antiquity, are built with this ſtone. They would have laſted through many future ages, eloquent monuments of the magnificence and taſte of the late Landgrave Charles of Heſſe-Caſſell, who built them, if their architect Guarneri had lined or covered them on the outſide with a more ſolid and durable ſtone, ſince all the volcanic tufos, and eſpecially the Heſſian ones, moulder away if expoſed to air, rain, and froſt. This ſeems to be owing to the want of a ſufficient

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* Remarks on the architecture and buildings of the ancients, p. 2—4.

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* Letters, p. 278, 279.

quantity of aſhes, and even to a change of theſe aſhes, deprived perhaps of their cementing and ferruminating quality by ſulphureous acids and damps, when thrown out with ſo many burning ſtones. There are ſome circumſtances to ſupport ſuch a conjecture. Expoſed for ſome time to rain and water, and even in the quarries, they appear ſpungy, and their holes are filled or incruſtated with whitiſh clay or marle, the reſult of aſhes and ſulphureous acids. Expoſed to fire, even to the ſtronger kitchen or furnace fire, they are laſting without decay, a quality of argillaceous ſtones.

§ 39. *The tufo deſcribed.*

The colour of our tufo is different, as its mixture and ſolidity; but commonly all its varieties are found in different beds in every quarry opened on the Habichwald. There is,

1. A blackiſh-grey;

2. A blueiſh-grey; and,

3. A yellow ſpecies; and every colour of different mixture and ſolidity. If they be of a fine grain, the incloſed lavas cinders and ſherls, being very ſmall, appear in the maſs of the ſtone like different ſtrata, and make the ſtone reſemble the product of water. The yellow ſpecies reſiſts the air leſs than any other.

§ 40. *Contains different ſtones.*

In the groſſer-grained ſpecies are to be obſerved, mixed and ferruminated with aſhes, a great variety of ſtones of different bigneſs, from the ſmalleſt point to a very conſiderable ſize; and theſe deſerve a cloſer examination, as giving evidence and conjectures about the nature and quality of the volcanos which threw them out, and about their deepeſt rock-ſtrata, to which ſome of them did belong in former times. Therefore I ſhall deſcribe all their different ſpecies,

cies, as obſerved by me in the walls of the caſcades and elſewhere, and rank them in different claſſes.

The *firſt claſs* is of ſuch ſtones as are ſtill raw and unaffected by fire, juſtly ſuppoſed to be thrown out and to be ſeparated from the deeper ſtone-beds, produced by water and belonging to pre-exiſting and perhaps original or primitive mountains.

The *ſecond claſs* is to contain the lavas and the products of fire, that is, ſuch ſtones as have been pre-exiſting in other forms, but have been by fire and heat affected, melted, changed, or conſumed.

The *third claſs*, which Mr. Ferber has not noticed at all in his volcanic accounts, ſhall contain the newer paraſitical ſtones, which have been in the tufo or lavas produced by water, ſoaking through their cracks holes and ſtrata.

§ 41. Claſs

§ 41. Claſs I. *Ancient ſtones.*

1. *White ſand-ſtone lumps*, pure and ſnow-white; now and then ſpotted with ſmall black iron-points; the grain extremely fine; their hardneſs, conſiſtence, and ſolidity, different; ſome friable to a fine ſand, which on account of its white colour ſeems to give a good ſort of glaſs.

2. The ſame ſort of *ſand-ſtone* externally *vitrified* into a hard yellow vitreous cruſt, which ſtrikes fire with ſteel. It is ſcarce in the tufo, and then but in ſmaller pieces; but common in large ſtraggling blocks and maſſes among the ruins of the Habichwald near the palace and the ponds of Wiſſenſtine. [Plate I.] Their nature, ſituation, and appearance, prove, 1. that they have been affected by fire, and even brought to vitrification; 2. that a ſpecies of white ſtraggling rocks, called in theſe countries *white wacke*, is but a more or leſs vitrified ſand-ſtone; 3. that the ſtrata under the

Habichwald of a fine ſand-ſtone are perhaps a continuation of the ſand-ſtone hills on the other ſide of the Fulde, which are called the Soere, and have been deſcribed before. Its exiſtence under the Habichwald is ſtill more evidenced by a ridge of large ſand-ſtone rocks near the palace of Wiſſenſtine, which appear above the cinereous ground on which it is ſituated. Their white ſhining colour is ſaid to have occaſioned the name of this place; and their romantic form, embelliſhed by convenient plantations of ſhrubs and trees, is one of the moſt picturesque objects of the noble garden which belongs to this palace. The fragments of white ſand-ſtone, dug out with black ſolid lava, of an old ſubterraneous gallery under the old or the ſmaller Winterkaſten behind Paul's-hermitage, and the ſand-pits near the Moriz-grotto behind the Sneckenberg, together with,

3. *Reddiſh ſand-ſtone*; and,

4. A like-coloured ſpecies with mica, both very common in tufo, had probably no other origin.

5. *White marle lumps*, effervescent with acids, are likewiſe incloſed in tufo, but ſcarce. They belong probably to the calcareous ground which ſurrounds this mountain, and on which it has been accumulated.

6. *Grey burnt clay*, reſiſting the acids, very common in tufo.

7. *Red*, and

8. *Yellow ochraceous burnt clay* is found in ſmaller fragments, which commonly break into concentric pieces. I have not hitherto obſerved in this tufo true calcined limeſtones, which in reſpect to the inferior calcareous ſtrata ſhould ſeem to be very common, and which Mr. Ferber has found ſcattered about Veſuvius, and incloſed in the Veſuvian tufo- and lava-beds.

§ 42. Claſs II. *Of volcanic ſtones, or immediate productions of fire, incloſed in the aſh- and tufo-ſtones of the* Habichwald.

9. All the above-deſcribed ſpecies of *aſhes*, being the ferruminating cement of tufo;

10. Fragments of *ſolid lava* of different ſize;

11. Ditto *ſpungy* and *honey-comb*;

12. Ditto *half burnt* and *extinguiſhed*, in the inner parts conſumed and burnt to cinders;

13. *Cryſtallized ſherl-maſſes* as deſcribed before. They are very often wrapt in a ſpungy or grey lava, fluid when thrown out.

14. *Lamellated ſherl*;

15. *Sherl-glimmer*; both in black lumps, remarkably large and ponderous.

16. A ſpecies of *white amianth*; has longitudinal fibres; ſmooth and ſaponaceous to the touch; ſcarce coherent; looſe; giving way to the preſſure of the fingers; light; for the moſt part ſwimming on water; reſiſting acids, and reſembling by its fibrous texture and lightneſs burnt wood entirely conſumed to aſhes. It is found in the tufo quarries in large but commonly flat pieces, wrapt in a ferrugineous ochraceous covering.

Though poſſibly our aſhes and tufos might, as well as the Italian ones, contain burnt wood *, and other adventitious organic bodies †, and therefore this ſubſtance be conſidered as the cinereous remains of burnt wood; there are ſeveral circumſtances which forbid ſuch a conjecture. Its ſnow-white colour certainly does not anſwer the idea of burnt wood, which in the Italian or

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* P. La Torre, Hiſt. of Veſuvius.

† Ferber, p. 146. 184—186. 237.

Herculaneum aſhes and tufos [*] rather reſembles charcoals, and its tender coherence and ſubſtance is as inconſiſtent with ſuch an opinion. But all theſe qualities, together with its fibrous texture, do exactly agree with the amianthine foſſil-cork (*Suber montanum Wallerii, Spec,* 148.), which is obſerved among the volcanic ſtones of Veſuvius [†], and according to Mr. Needham's obſervations nearly related to the lighteſt cinders, conſiſting only in an iron calx, entirely deprived of its phlogiſton [‡]. An intenſe volcanic fire might probably occaſion ſuch an operation. Whether our *amianthine cork* might be by furnace-fire brought to a black vitrification like that ſpecies which Wallerius has deſcribed, or whether it might like other ſpecies of amianth and aſbeſt, reſiſt the furnace, and yield only to the burning mirrour, is to be tried by future chemical experiments.

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[*] La Torre, l. c. Winkelmann's Letters on the Herculaneum diſcoveries, 1762, p. 13. 63.

[†] Ferber, p. 159.

[‡] Mem. de l'acad. R. des Sciences, 1760.

§ 43. Claſs III. *Or the paraſitical ſtones produced by water or ſteams in the ſubſtance of our tufo, contains,*

18. *Whitiſh* and *yellowiſh clay* depoſited in its ſpungy holes;

19. *White calcareous ſpar*, which has incruſtated and filled theſe holes, very common in the tufo-quarry behind Paul's-hermitage in the gardens at Wiſſenſtine; of a fine grain; very compact, but leſs than the horn-flinty depoſitions of the Vicentine achates or rather chalcedonius enhydros; leſs likewiſe than the ſimilar horn-flint concretions in our ſounder lavas, which I have mentioned before.

20. *Calcareous ſpar*, of a yellow and whitiſh colour in large cryſtals, found in ſtraggling tufo-pieces near the crater at Frankenhauſen.

21. *Ochraceous iron-ore*; breaks concentric; light; reſembling ſome richer button-ores; found in lumps, like indurated clay in the tufo-quarry behind Paul's-hermitage.

§ 44. *Recapitulation and concluſion that the* Heſſian *lavas are ſomewhat different from the* Italian *ones.*

Thus far of the ſtone- and earth-ſpecies, which have occurred to me in the ſolid beds of the Habichwald, the Dornberg, and other ridges or iſolated conical hills of that kind. Theſe I have been obliged to conſider as volcanic, 1. ſince, being evidently accumulated and ſuperincumbent on marine beds, they cannot be ranked among the pretended original or primitive mountains; 2. ſince their ſtructure, beds, and foſſils, do not agree with any known ſpecies of modern mountains but the volcanic; 3. ſince they agree in moſt part of their qualities with the nature of many Italian volcanos and volcanic productions; and ſince, 4. they manifeſtly ſhow marks of ſubterraneous fermentation, heat, eruption, and fire, in their ſtructure, as well as the vitreous ſlaggy nature of their foſſils. I have ſeen, and obſerved, without prejudice. This I am conſcious of, and will I hope appear to every one, who is willing and able to ſee without prevention. According to this my impartiality I have freely acknowledged, "that in the lavas "of Veſuvius and its neighbourhood, no "priſmatical columnar lavas or baſaltes "have been obſerved; and that our lavas "differ from thoſe which Mr. Ferber has "examined near the Veſuvius and other "unequivocal volcanos in Italy, on account "of their peculiar and hitherto unobſerved "cryſtallized ſherl-maſſes." And with the ſame impartiality I acknowledge ſtill further, "that the ſtill burning volcanos in "Italy, Veſuvius, and Solfatara, offer ſe-"veral phænomena, which are not to be

" found or obſerved in our extinct volca-
" nos." Such are, beſides ſeveral foſſils deſcribed by Mr. Ferber [*],

1. The hot wells and ſteam-baths in the neighbourhood of Veſuvius [†];

2. The ſuffocating damps and ſteams (moffette) of ſeveral volcanic tufo-caverns near Veſuvius [‡]; and,

3. The yellow native ſulphur;

4. The red arſenic;

5. The green vitriol;

6. The ſalmiac; and,

7. The alum; which in the inner crater of Veſuvius and Solfatara are ſublimated and depoſited [§]. But all theſe differences

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[*] Letters, p. 158, 159—184.

[†] Ibid. p. 187. 199—203. La Torre Hiſt. of Veſuvius.

[‡] La Torre, l. c.

[§] Ferber, p. 181—184. 192—196.

intitle nobody to conclude, "that our "Heſſian baſaltes, black rocks, tuſo- and "tarras-ſtones, are neither lavas nor of a "volcanic origin." The only concluſions, which fairly may be drawn from theſe circumſtances, and in which I perfectly agree, are, "that our volcanic ſtones, lavas, baſaltes, and tuſo-ſtones, are, on account "of their ſubſtance and mixture, ſomewhat different from the Italian ones *; "and that our volcanos, extinguiſhed and "entirely refrigerated ſo many centuries "ago, cannot poſſibly produce the ſteam- "ſulphur and ſalt-ſublimations, which are "entirely depending on the action of ſtill- "burning and operating ſubterraneous heat "and fire in Veſuvius and Solfatara." Their containing the requiſite materials for many, if not for all theſe ſublimations, appears by their deſcription, and will appear ſtill more by their future chemical analyſis.

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[*] The Iceland lavas and volcanic production (and who will doubt their origin?) are certainly as much if not more different from the Italian ones.

§ 45. Some

§ 45. *Some general account of other German volcanos.*

Thus we may be without any predilection to the volcanic ſyſtem convinced, that the Habichwald and the adjacent Dornberg are volcanic mountains. Their remarkable elevation, their large extent of at leaſt 20 Engliſh miles ſquare, and their preſent exterior appearance, ſeem clearly to indicate, that ſubterraneous fermentations, heat, and fire, worked many centuries to raiſe and accumulate them by many eruptions upon a calcareous marine ground, and perhaps in the midſt of an ancient ſea; but that water, rain, froſt, and the inclemencies of the atmoſphere ſince times immemorial, have been at work to deſtroy and to level them again.

Iſolated, and for the moſt part conical ridges and points of baſaltes, of a like origin, and of the ſame remote antiquity, are diſperſed all over Heſſe; and there ſeems to begin in Lower-Heſſe in the neighbourhood of Caſſell a chain of volcanic-hills, running through Upper-Heſſe and the Wetterau to the Mayn and to the Rhine, nay perhaps through Thuringia and Franconia to the Saxonian * and Bohemian mountains, which partly are known to be of a volcanic nature †. I would not however engage to prove, that, in the ſtricteſt ſenſe, there are chains of volcanic mountains; however it is highly probable, that there is in Ger-

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* For example, at Stolpen near Dreſden.

† Baron Born's account of an extinguiſhed volcano near Eger in Bohemia, printed in German, Prague, 1773; and Ferber's mineralogical deſcription of Bohemia. Luſatia and Sileſia are bordering to Bohemia, and Luſatia has a columnar baſalt-hill near Griffenberg, as Sileſia ſeveral others of that kind, which have been imperfectly deſcribed and drawn by Kundmann in rarioribus naturæ & artis. According to Baron Born's travels in Hungary, the Carpathian mountains are not deſtitute neither of that natural curioſity. I do not ſpeak of ſimilar obſervations made of late in Dalmatia, nor of thoſe made in France.

many a long ſuite or ſucceſſion of volcanos, comparable to that in Italy, which begins in the Southern ſkirts of the Alps in the Venetian State, runs on both ſides of the Apennines into the kingdom of Naples, and ends beyond the Æolian and Liparean Iſlands in Sicily *. My conjecture is ſupported by theſe facts. Beginning from the Habichwald, there are on the N. W. ſide of the Fulde, through Lower- and Upper-Heſſe up to Francfort, a great many iſolated baſalt-hills. Of that kind is the Deſenberg in the biſhoprick of Paderborn; nearer to the Habichwald and Dornberg in Lower-Heſſe, the caſtle-hill at Grabenſtine, the baſalt-hills near Gudenſberg, Felſberg, and Aldenburg, and thoſe in the Widelſberg near Wolfhaguen. In Upper-Heſſe nearer to the Mayn there is a baſalt-hill near Volckerſhauſen, and another on the Vogelſberg at Bilſtine †. They are com-

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* Ferber's Letters.

† Ritteri Tentamen hiſtoriæ naturalis Riedeſelio-Avio-montanæ in Tomo x. Actorum Societatis naturæ curioſorum.

mon about Gieſſen. The caſtle of Amœneburg is ſituated on ſuch a hill; Wilburg in Naſſau likewiſe. Near Francfort on the Mayn, at Bockenhime, and near Andernac on the Rhine, the ſame volcanic tarras is found, which I have diſcovered on the Habichwald among many ancient traces of volcanic fire. But in the Northern parts of Germany, in Weſtphalia, the Electorate of Hanover, the Duchy of Brunſwick, the Hartz-Foreſt, the Biſhoprick of Halberſtadt and Magdeburg, the Duchy of Anhalt, and the Marches of Brandenburg, there have not been till this moment ſeen by me, or as far as I know found by others, any priſmatical baſaltes or other unequivocal marks of volcanos.

PART III.

UTILITY OF THESE ENQUIRIES, AND OF THE VOLCANIC PRODUCTIONS.

§ 1. *General remarks.*

PEOPLE, to whom the very name and idea of a volcano is frightful, and to whom neighbouring-volcanic ruins cauſe dreadful dreams of the earth-ſhaking conteſts of Pluto and Neptune, of the furnaces of Vulcan, or what is worſe, of the eternal combuſtion of hell, objects and fancies by fools and poets ſeen in volcanos, will certainly bleſs theſe countries for being deſtitute of ſuch troubleſome objects. They will aſſure us perhaps, "that ſleep and "life is ſurer where neither the marks of "ancient deſtructions are to be ſeen, nor "their returning rage to be apprehended. "Why will you force upon us old volcanos, unnoticed by hiſtory, and *good for "nothing?*" But there is much to be ſaid to ſooth ſuch apprehenſions. We live here on and near the ruins of our extinct volcanos, as quietly and as ſecurely as we ſhould reſt on the moſt bloody fields of ancient battles, or on the tombs of raging tyrants. Times immemorial their forces have been exhauſted or quiet, and their preſent diſtance from the ſea gives ſome hopes that they will be ſo for ever. They are beſides *good for ſomething*, as ſhall be proved preſently; and this will juſtify the pains and care I have taken, and which other people may take, in their future examination and deſcription.

I will not dwell much on the pleaſure which enquiries of that kind afford to the mind and the imagination; they are naturally bent to pry into the remoteſt antiquity, and into the firſt cauſes of things. But this pleaſure, being perſonal, might perhaps be enjoyed, though the object of its enquiries be without any utility and advantage to human ſociety. However, it may be a means of uſeful knowledge; and ſuch is the conjecture and the conviction, that ſeveral of our mountains are of a volcanic origin.

§ 2. *Enquiries of this kind improve the knowledge of the phyſical geography, and the expenſive art of the miners.*

This knowledge improves and corrects our ideas concerning the origin and the natural viciſſitudes of the ſurface of the earth; points out ſeveral dangerous errors, and teaches us to find at home ſeveral ſorts of uſeful foſſils, which either were not noticed at all, or were even at great expence imported from abroad—objects that certainly cannot be indifferent to a friend of truth, nor ſeem ſuperfluous to a lover of his country, or to a man that once has felt the conſequences of error! Every error is attended with its own natural puniſhment, and eſpecially blunders committed in the expenſive working of mines, whoſe puniſhment never fails to be immediate and extremely ſenſible. Such errors might be committed, and I am apprehenſive have been committed very often, if in hope of metallic veins one ſhould venture to ſink ſhafts and to drive galleries through the vitreous rocks of volcanic mountains. They yield nothing but clear loſs of money, pains, and time. Being accumulated by aſhes, lavas, and ſtraggling vomited ſtones, they may now and then contain in their melted maſſes and cinders ſome marks of metals; but their very nature forbids to hope or to look in them for metallic veins, which, by the ſubterraneous fermentation, heat, and fire, are deſtroyed and melted into one maſs, with the unweildy barren rocks that ſkirt them on every ſide. There has been under the late Landgrave Charles of Heſſe, ſunk a pit and a gallery through a baſalt- and lava-rock, under the ſmaller Winterkaſten at the Habichwald. The gallery is ſtill open, and is called the ſilver-well (ſilver-brunn). If theſe amazing ſubterraneous works have been undertaken on account of the caſcades or the coal-pits, which are on the other ſide of the hill, they may perhaps be excuſable; but if there has been any intention to fiſh for ſilver in the ſilver-well, as ſeems to appear by its name, the enormous expences have certainly been thrown away, and would have been ſaved by a better acquaintance with the nature of the whole mountain.

§ 3. *Uſe of the volcanic productions.*

I have given a deſcription of the different earths and ſtones which have occurred to me in the Habichwald and other volcanic hills; and their number might perhaps be augmented by ſuch foſſils as Mr. Ferber has found in the Italian volcanos; but, leaving this to future enquiries, I will at preſent dwell only upon the utility of the former.

§ 4. *Uſe of the baſaltes and the harder lavas.*

The ſolid lavas and baſaltes, on account of their remarkable hardneſs, are called *pietre dure** and *ſelce*†, and are employed in that country as well as in Heſſe; 1. *in the paving of ſtreets and roads.* Their plenty, hardneſs, and durable ſolidity, ſerves that purpoſe extremely well. They have been employed likewiſe, 2. *in walls of maſonry*, as appears in the walls of many old caſtles and other pieces of old architecture in Germany; but, having been employed in their rough and irregular natural form, ſuch walls are not to be commended. If the ſtones were cut into regular forms, it would make ſuch walls extremely expenſive, and in every other reſpect comparable to the everlaſting Egyptian granite-architectures. In a natural priſmatical form they ſerve at Felſberg, 3. as *poſts on the ſtreet-corners*; and, 4. as *palliſadoes* to fence gardens and fields. They are ſet up cloſe together, and thus make a fence or hedge of everlaſting duration. However, they are ſeldom employed for this purpoſe, the carriage of the larger baſalt-priſms being difficult and expenſive. Some time ago the diſperſed regular and priſmatic baſalt- and lava-pieces have been employed in the gardens at Wiſſenſtine, 5. *to border and to decorate ſome artificial brooks, ponds, natural caſcades, and terraces, and to build occaſional ruſtic chairs and ſtairs.* Being very frequent within this noble garden on the deſcent of the Carlſberg, as well as in many pictureſque and ſolitary valleys, they had been very troubleſome to the gardeners, and rendered the clearing of the ground difficult and expenſive, till the preſent gardener Mr. Swarzkopf, a man of taſte and genius, had the happy idea to ſave time and expence, and to employ Nature's ſelf to Nature's advantage. He compoſes theſe ſtones in whatever form he wants, or the ſituation aſks and permits. Moſſes and paraſitical plants and ſhrubs ſerve inſtead of lime or cement. By this artifice he has produced a great many picturеſque views, and many awful and ſingular objects, anſwering the wildneſs of their ſituation. Such are the rocky incloſures of Paul's-hermitage, in a lonely dale, ſurrounded on every ſide with hills and woods; the rivulets and caſcades which from that valley, by many windings, and through many ſhrub- and tree-plantations, fall down to the Styx and the Chineſe ponds; ſimilar brooks under the Parnaſſus and Elyſium on and near the Sneckenberg; and the ſteep rocky walls behind the Monuments of the Illuſtrious. You cannot imagine any thing more ſimple, pictureſque, and ſublime. You ſee here Nature, venerable moſſy antiquity, and ruſtic ſimplicity, together.

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* La Torre.

† Ferber, p. 230.

Hitherto I have not found theſe baſaltes and ſolid lavas employed in Heſſe to other uſes; but they are fit even raw, 6. to *rocaille work in grottos*; and taking a fine poliſh they might be, according to the example of the Ancients and the Italians, 7. *cut, poliſhed, and employed in ſeveral works of architecture and ſculpture.* The ſlate-like lavas near the old or the ſmall Winterkaſten would be, I think, moſt convenient to tables and flat architectonical incruſtations. Whether chemiſtry, by an exact analyſis of its particles and ſherl-maſſes, will demonſtrate them to be of ſtill greater uſe, is uncertain. Beſides the iron which commonly they contain, there might perhaps in ſome lavas appear ſome marks of nobler metals; but theſe I fear will never pay the expence.

§ 5. *Uſe of volcanic tarras, neglected in* Heſſe.

The *tarras-ſtones* have not been till this moment employed in any thing in this country. I am ignorant why this ſhould happen. *Guarneri*, a Roman Architect, who executed the caſcades and buildings at Weiſſenſtine, ſaw immenſe quantities and beds of this ſtone on the very ground where he reared the octogon [Pl. I.]; and being an Italian, he ought to have been acquainted with the uſe of puzzolana, ſo nearly related to this tarras, and of the volcanic cinders ſo commonly uſed in his country. But he had perhaps perſonal reaſons not to ſee and to employ materials which were ſo obvious to him, and might have leſſened the expence of the buildings, and diminiſhed the enormous weight of the whole ſtructure, eſpecially in the bold vaults which ſurround and ſupport it.

§ 6. *Tarras and volcanic cinders employed by the Ancients in caſt vaults and walls.*

Our tarras-ſtone can with great advantage ſerve in maſonry, but eſpecially in vaults. Being very light and ſpungy, its preſſure and gravity is inconſiderable, and its coherence with lime and mortar inſeparable. For this reaſon the Ancients and Italians have frequently employed this and the like ſorts of ſtones. I ſhall prove that by the late *Abbé Winkelmann's* authority, and with his own words, which, in his *Remarks on the buildings and the architecture of the Ancients*, p. 9. run thus: "The Ancients, making their vaults very thick, "wanted to have them as light as poſſible. "This they effected by two means: the "moſt common was, to build vaults with "Veſuvian ſcoriæ. Theſe are reddiſh, or "of a grey colour. A black ſpecies is dug "out near Viterbo, in a place adjacent to "ſome hot-wells. But theſe Viterbo ſlags

" being not remarkably hard, are rather
" unfit to be employed in vaults. The Ve-
" ſuvian ones do manifeſtly appear in old
" vaults. They have been occaſionally ob-
" ſerved in the late reparation of the Pan-
" theon. Vitruvius is ſilent about this
" manner of vaulting; and he mentions
" our Veſuvian ſlags but by the bye. The
" nature of Veſuvius being ſcarce known to
" the Ancients, they had neglected too the
" examination of the Veſuvian products.
" Vaults of ſuch ſcoriæ are very common at
" Naples; but Cardinal Alex. Albani has
" made at Rome the firſt and till now only
" experiment to revive this old practice, or-
" dering and executing ſuch vaults in his
" villa. The proceeding is thus; the cen-
" ters or the ſcaffold for the wall being
" erected, they lay the arch on both ſides
" *(le coſcie della volta)* in the common way
" up to the middle, and then ſhut or crown
" it with ſcoriæ and mortar, which penetra-
" ting into their ſpungy ſubſtance, makes
" ſuch vaults almoſt indeſtructible."

§ 7. *Example of a caſt vaulting of calcareous tophus in* Germany.

Every light and ſpungy ſort of ſtone would ſerve to the ſame purpoſe; and I remember to have ſeen at Lamſpring, an Abbey of Engliſh Benedictines in the Biſhoprick of Hildeſheime, very large vaults of a light calcareous tophus or oſteocolla. Neceſſity had laid them. The architect of the church had by ignorance or neglect reared its exterior walls ſo thin, that they were thought and found inſufficient to ſupport the weight of a ſtone-vault. Therefore the church ſtood a long while unfiniſhed, till at laſt they happily adviſed and executed a vault of this ſpungy calcareous ſubſtance, which, without incumbering or damaging the exterior walls, ſupplies very well the want of a heavier one, though it ſhould not be proof againſt bomb-ſhells, being every where penetrable even to the blade of a ſmall ſword.

§ 8. *Volcanic tarras gives an excellent cement.*

But the greateſt, though in our countries moſt neglected, uſe of *tarras*, is its giving *an excellent cement.* I do not repeat what I have ſaid about its volcanic origin and nature, which explains why it ought and might have the qualities of the Italian puzzolana.

§ 9. *The puzzolana deſcribed according to its volcanic origin, uſe amongſt the Ancients, and its preparation.*

This puzzolana is an aſh-powder, or rather pulverized cinders, found various-coloured about Naples, and black-coloured on Veſuvius *. They dig it white and grey in the hills near Puzzuolo; brown and yellow at the foot of Veſuvius †. It is likewiſe found near Rome in the before-mentioned colour and reddiſh[*]. It is produced by conſumed cinders and ſcorified lavas; that is to ſay, by our tarras-ſtone, which reſembles the ſcorified lava-fragments to be found in the Roman *puzzolana*[†], for which reaſon our tarras-ſtone may be preſumed to have the ferruminating and cementing quality of the puzzolana. This quality has been chemically analyzed by Mr. Ziegler[‡], and is, that puzzolana mixed with a convenient quantity of calcined lime-ſtone and water heats, and if heated and immediately employed as mortar, coagulates to ſuch a degree of hardneſs and ſolidity, that water cannot diſſolve or penetrate it[‖]; nay, the mortar grows harder than even the ſtones which it is intended to bind. This appears in the bedding or the ground of an ancient Roman-muſaïco kept in the Landgrave's cabinet of antiquities. But the faireſt proof to be given of it is the preſent ſtate of the ſubaqueous ruins at Puzzuolo, Baja, and thereabout, and at Porto d'Anzio, where the pillars which incloſed the harbour are built of tiles. The Ancients employed the puzzolana likewiſe in the neighbourhood of Rome in the public roads; a practice not uncommon even in our days[*]. The black puzzolana is ſaid to be excellent in buildings under water[†]; and the Ancients are ſaid to have employed it on ſuch occaſions more than any other. However, other ſpecies duly mixed and prepared may anſwer the ſame purpoſe. For this reaſon the puzzolana is by large cargoes exported from Italy into France, Holland, England, Sweden, and many other countries.

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* Ferber, p. 147. † Ibid. l. c. p. 180, 181.

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[*] Ferber, p. 234, 235, 236. Winkelmann on the archit. of the Ancients, p. 6, 7, 8.

[†] See before.

[‡] Magazine of Hanover, Nov. 21, 1774.

[‖] Ferber, p. 147.

The preparation of puzzolana cement is as follows. Three or four parts of this ſubſtance finely pulverized are to be mixed with one part of well-calcined limeſtone, likewiſe pulverized; then a good deal of freſh water is to be put upon that mixture, and the fluid maſs to be turned and worked about till it begins to heat and to inſpiſſate, when it is ready to be uſed and to be employed immediately; but care is to be taken that the walls and maſonry made with puzzolana cement be covered for ſome time from ſun-ſhine, and be kept wet by putting water upon them; elſe the cement will never coagulate entirely, and get its perfect ſolidity. It appears by this proceeding that puzzolana cement cannot be properly applied to common maſonry, unleſs every tile or brick be ſufficiently watered, and then lined with the ſtill warm cement, and that its ſudden inſpiſſation makes it naturally fit for incruſtation, and expeditiouſly making large walls and vaults. The late Abbé Winkelmann deſcribes it in the following paſſage, taken from his remarks on the architecture of the Ancients;

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[*] Winkelmann's Remarks on Architecture, p. 7.

[†] Ibid. p. 6.

"We begin with the foundations, which "the Ancients laid either with large ſquare "pieces, or with ſmall fragments of tufo. "The laſt method was the moſt common, "and is ſtill uſed in Italy. They firſt dug "out the ground, and then filled the holes "by ſucceſſively putting in puzzolana-mortar and tufo-ſtones. Such a cement bed "coagulates in a couple of days, and gives "an excellent ſolid foundation. But it is "to be obſerved, that even in ſuch maſonry "above ground the Ancients employed "more cement than ſtone, which is a conſequence of its petrifying quality. Many "old vaults have been executed by the "ſame method. The ſcaffold having been "properly covered with wainſcot or deal, "they put the above mixture of cement "tufo or broken bricks and tiles upon it to "a determinate convenient thickneſs, which "in the Diocleſian Thermæ is of nine palmi; "afterwards they covered and leveled the "whole by a bed of cement. By this "means large vaults could be finiſhed in a

“ few days. That the Ancients commonly “ uſed it, is to be ſeen in old vaults, where “ they have given way, or loſt their incruſ- “ tation, as in the Colliſeo, in the Thermæ “ of Titus, Caracalla, and Diocleſian, but “ eſpecially in the vaſt ruins of the villa “ Hadriani, where even the impreſſions of “ the ſcaffold-deals are to be diſtinguiſhed.”

This expeditious method of caſting walls and vaults is at preſent out of practice; however they continue in Italy to make their vaults with tufo and puzzolana, but as in common maſonry; and then they crown and level the whole up to the back of the vaults with a caſt cement-bed, which caſting they call *far a ſacco.*

§ 10. *The caſting of walls and vaults by a puzzolana cement, uſed by the Ancients and the* Italians, *recommended.*

This caſting of foundations, walls, and vaults, ſuppoſes a plenty and low price of puzzolana, and cannot be probably revived or introduced in countries where puzzolana muſt be imported; however, on account of its expeditiouſneſs, which ſaves time and money, it certainly deſerves great attention, wherever puzzolana is an inland commodity, or where, inſtead of puzzolana, there is to be found a tarras-ſtone, endowed with its ferruminating quality.

§ 11. *The* Heſſian *tarras proved by fact to give an excellent cement under water, and to be equal in goodneſs to the* Dutch *tarras.*

But here a queſtion ariſes, "whether our "Heſſian tarras may be employed and "worked as puzzolana? or whether it will "give a cement in force and goodneſs equal "to puzzolana cement?" This queſtion has been anſwered to its advantage, not only by its origin and nature, but, what is above all reaſonings *à priori*, by a great many experiments, which have been tried by me and by Colonel Gohr, in ſeveral greater works under and above water at the Carlſberg caſcades at Weiſſenſtine.

I hope, therefore, not only that our tarras may be henceforth conveniently employed in the country, but that it may be exported by the Weſer, Carlſhaven, and Bremen, to Holland and other Northern countries. For many years the tarras found near Bockenhime and Andernac on the Rhine has been exported in vaſt quantities to Holland, and thence to the North, though cuſtoms and duties make it very dear [*].

The *aſhes and friable cinereous ſtones* deſcribed above, may perhaps give likewiſe a good cement. They would ſell ſomewhat under the price of tarras, as not wanting to be pulverized, which cauſes ſome, though inconſiderable, expence. But, having made no experiments on their nature, I recommend them in the probable hope of their not being unſucceſsful.

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[*] The buſhel of ſtampt tarras imported from Holland ſells at London wholeſale for three ſhillings, or above. It might be had from Bremen at a cheaper rate, and in equal goodneſs, if ordered from the Heſſian Company of Commerce eſtabliſhed at Carlſhaven on the Weſer; who, applied to under this addreſs, will ſupply any demands.

§ 12. *Mineral waters produced by the volcanic aſhes in the garden at* Weiſſenſtine.

I mentioned before, that a cinereous ſtratum under the Habichwald imparts to the water, which is ſoaking through it, a mineral and ſaline nature. Accordingly, it cauſes *mineral waters*, which on nearer obſervation I have found to be impregnated with ſome ſal medium, vitriol, iron, and ſulphureous acid. A well of ſuch water appears under the bowling-green in the garden at Weiſſenſtine above the Styx, and another runs through the wall of a terrace before the gardener's houſe; both manifeſting themſelves by ochraceous ſediments, and a volatile ſmell of hepar ſulphuris.

But, not being properly incloſed, and for that reaſon much adulterated by rain and other water, their mineral taſte and mixture is weak at preſent, and will continue ſo till ſome famous and popular phyſician ſhall pleaſe to take this water under protection, and give it virtue and celebrity. Wells of a like, or even a different mineral nature, ought to be common round about the Habichwald, and other volcanic hills, eſpecially in their cinereous ſtrata.

The uſe of tufo being known; I conclude with wiſhing that theſe ſmall diſcoveries may meet with a good reception, and be a recommendation of too much neglected Natural Hiſtory.

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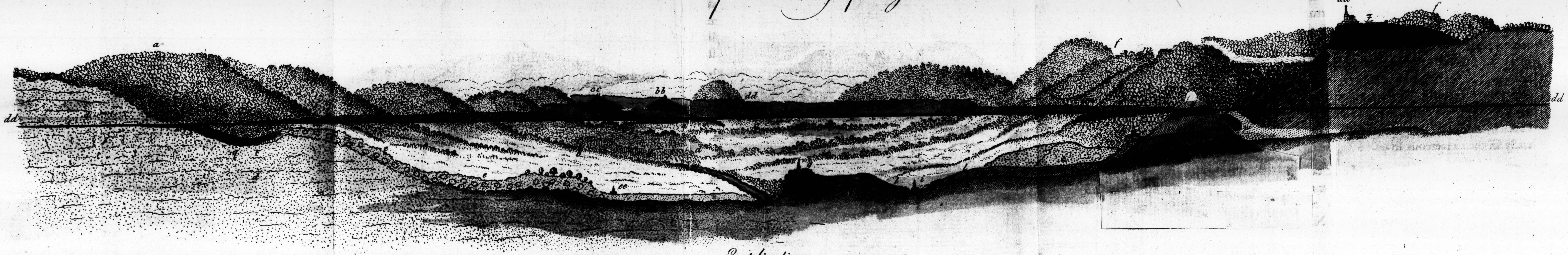
THE END.

P. vi. l. 14. *for* nomenclator *read* nomenclature.

Plate I.
To face p.16.

Section of the Valley of Caſsell



Explication

a, The Soere-Forrest
b, Berghousen
c, Fulda river
d, Sandſtone
e, Dragged & ſtragling Sandrocks
f, Habichwald

g. Caſsell
h, Wineberg & Krazenberg; limestone
i, Welhiden
k, Weiſsenſtine
l, Decays of the Habichwald
m, Druselthal

n, Wahlershousen
o, Aſhes
p, Sneckenberg
q, Littoral calcined Shells
r, Deſcent to Lower-Kauffung
s, Beſſe

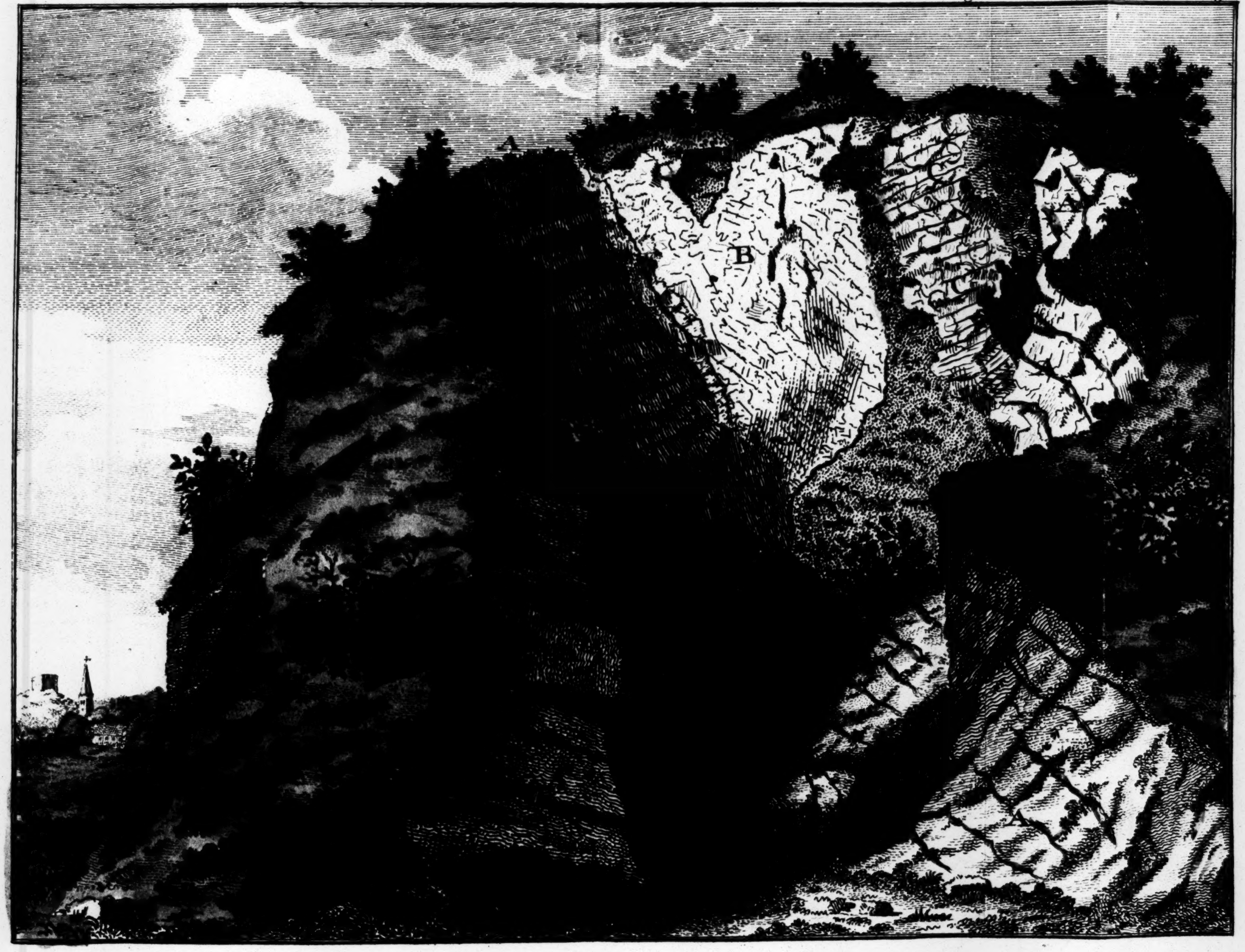
t. Deuten
u. Guderſsberg
v, Basaltes or Columnar Lava
w, Sand & Clay
x, Globular Lava lumps
y, Lava bed & aqueduct

z. Slags or Tarras
aa, Octogon at the Carlſberg
bb. Felſberg } Columnar Basalte
cc. Aldenburg } Columnar Basalte
dd. Level of an ancient Sea
ee. Beltenhausen

Scale
1 French League 25 to a Degree.

Volcanic Crater near Frankenhousen in Lower Heſse.

Plate II.
To face p. 38.



A. *Calcareous Strata.* C. *or* 3. *Beginning of a running Lava.*
B. *Hanging Lava*

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